The Dominions and the bomb
Commonwealth involvement in the British nuclear weapons programme, 1939 - 1947

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THE DOMINIONS

AND

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Abstract

This thesis considers the significance of the Dominions in the early stages of the UK nuclear weapons programme, seeking to determine how the Commonwealth, as a constitutional and cultural reality, shaped the UK's pursuit of nuclear weapons between 1939 and 1947. The thesis unites two prominent lines of historical enquiry: the history of Britain's engagement with nuclear weapons on the one hand, and the complex and evolving relationship between Britain and her Dominions in the late imperial/early decolonisation period on the other. Both strands are prominent in British (and world) history, but the two have always tended to be treated in isolation. The contention of this thesis is that the two are in fact more intimately linked than has been thought, and that an understanding of the enduring – and evolving – role of the Commonwealth in informing every form of British policy-making can enhance existing interpretations of British nuclear history.

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Introduction:
A Neglected Aspect of Nuclear History

This thesis addresses a consistently overlooked and under-researched aspect of British nuclear weapons history – namely, the interactions between Britain and the other Commonwealth Dominions as an influence on the character and trajectory of the British programme in its earliest stages. The need for fresh scholarship in an ostensibly well-served field is best justified by the demonstration of a deficiency in existing accounts. In the case of British nuclear history, the core narrative is straightforward enough: recognising the possibilities of uranium fission in the early stages of the Second World War, Britain initiated a research programme, small in scale but earnest and effective, which was eventually subsumed into its far larger American counterpart. The result was the development by the allies of the first atomic weapons, used to devastating effect by the Americans over Hiroshima and Nagasaki in the closing stages of the war in the Pacific. Peace, and the new atomic reality, then introduced a degree of distance between the allies, and an official decision that Britain should pursue an atomic capability of her own was soon taken. Historians' accounts of these formative years have sought to add analytical substance to this core narrative, but for all their efforts there remains a lacuna in the literature.

The lacuna is this: existing accounts fail adequately to recognise that the 'British' nuclear programme was not conducted exclusively within, by, or for the United Kingdom, but rather incorporated personnel and material from across the Commonwealth. Mark Oliphant, one of the principal actors in the early British programme, was an Australian; the first reactor on which British personnel worked was built in Canada, under the aegis of the Canadian government, with a mixed Anglo-Canadian workforce; much of the engineering work on the first Canadian and British reactors was conducted by a New Zealander, Charles Watson Munro. Scientists and policy-makers from the Dominions had exposure to pivotal aspects of Britain's nuclear research and development effort throughout the war and in its immediate aftermath, not merely as observers, but as key contributors. Thus even in the earliest stages of her nuclear history Britain cannot be said to have acted alone: in varying forms and to varying degrees the British nuclear programme relied on interactions with the Commonwealth. Yet the presence of this Commonwealth element in the UK nuclear programme has generally been downplayed by historians, and in many instances wholly ignored. Some accounts of individual Commonwealth countries' experiences with nuclear technology do exist, and these at least address aspects of these countries' interactions with the United Kingdom, but no monograph yet written has considered the significance of the Commonwealth collectively, nor made adequate reference to the liminal state of UK-Dominion relations that formed the constitutional context for the period in view.

It is somewhat puzzling that such a historiographical gap should exist. The inclusion of Commonwealth personnel in the British nuclear weapons programme was a *de facto* transfer of knowledge beyond the bounds of UK government control, and was perceived as such almost from the outset. The fact that the UK government willingly (indeed, reflexively) permitted the transfer of sensitive information to states which were effectively sovereign, and that it depended on the willing co-operation of these increasingly independent-minded partners to develop (and later test) nuclear weapons technologies, might be considered

worthy of greater attention. One might also expect more interest to have been shown by historians in the overlap between the two great strategic realities facing Britain in the immediate post-war period: the emergence of the atom bomb and the reconfiguration (and decline) of the Empire-Commonwealth system. The two were synchronous, and, as shall be seen, intimately linked, yet few treatments of one issue make serious reference to the other. The result of such omissions can only ever be the restriction of historical analysis: neglect of a relevant factor necessarily distorts a historian's account. This thesis therefore aims to provide a corrective narrative.

Since this thesis takes as its starting point an apparent gap in the historiography it is important first to demonstrate the reality of that gap, and to situate it within the wider contours of nuclear history. The remainder of this introduction therefore examines the ways in which the early history of nuclear weapons (and Britain's relationship thereto) has been written, assessing the biases and detecting the gaps in these accounts, and asking what attention has been paid to the role of the Commonwealth, and by whom. This process of literature review then forms the basis for the thesis' historiographical approach.

The Contours of Nuclear History

The first attempt to chart the history of the atom bomb was written before its subject had been deployed in anger – indeed, before it had even been tested. The potential significance of the nuclear undertaking had become apparent almost immediately the projects were begun, and by the summer of 1945 the Americans' official report *Atomic Energy for Military Purposes* had been in preparation for months, ready for swift publication when the moment came. Its author, Henry DeWolf Smyth, completed his preface on 1st July 1945, predating the Trinity Test by more than a fortnight, and the report was released to the public on 12th August 1945, mere days after the bombings of Hiroshima and Nagasaki. A far shorter British statement was released the same day and a Canadian counterpart the next. Both were eventually incorporated into the published version of the Smyth Report as annexes, but only from the fifth edition (1st November 1945) onwards: the earliest print runs carried solely the American document.[1] Smyth himself made no claim regarding the completeness of his references to work conducted by the British or Canadians, instead writing only from an American perspective.[2] The focus of Smyth's analysis was essentially on the American achievement, with the British contribution limited to a handful of helpful interventions (and the Commonwealth aspect only implied in passing). Britain's main role is held to have been as an early stimulant to the American effort: Britain's initial progress helped transfuse a sense of urgency – and credibility – into the American project.[3] The informal representations of Mark Oliphant, a UK-based, Australian-born physicist (erroneously identified by Smyth as English) are portrayed as crucial to this process.[4] Once the Manhattan Project itself is introduced, Britain recedes from the narrative foreground: the involvement of British and Commonwealth personnel, other than in the work at Berkeley, is not referenced, although the inclusion of the British and Canadian statements in later editions at least made it clear to attentive readers that such activity had taken place.

[1] Henry DeWolf Smyth, *Atomic Energy for Military Purposes* (Princeton: Princeton University Press, 1948 republication), pp.vi-vii
[2] Ibid., p.vi
[3] Ibid., p.53, p.71
[4] Ibid., p.53

Smyth's report set the pattern that most subsequent American histories would follow. The most notable influence was on Richard Hewlett and Oscar Anderson, whose appointment by the United States Atomic Energy Commission in 1958 to the task of preparing an official history was considered by Lorna Arnold (a British official historian of later vintage) to have marked the effective birth of nuclear history as a discipline.[5] Their end product, *A History of the United States Atomic Energy Commission, Volume I: The New World, 1939-1946*, was undoubtedly 'official'. The privilege of archival access is stressed throughout. This sanctioned historical account follows Smyth in depicting America as a broadly independent nuclear actor, and surpasses him in stressing the American achievement. The picture of Anglo-American wartime nuclear interaction emerging from Hewlett and Anderson's account is one of patchy and awkward collaboration: the fact that the chapter on the US-UK relationship is called 'An Uneasy Partnership' is indicative of the overall tone. Britain is by no means ignored; much in fact is made of their use of archival materials to provide a 'satisfactory account of the intricate wartime negotiations' with Britain and Canada, but the account is not wholly favourable.[6] Britain is largely side-lined, and the early British contributions are played down. Canada fares worse still, and whilst a wider imperial dynamic is occasionally assumed it is never elaborated.[7] The end result is a history that is honest in intention but unduly constrained by its adherence to an exclusively American perspective which therefore lacks explanatory power.

Later, unofficial, American accounts have trodden similar paths, almost invariably with even less sensitivity to commonwealth dynamics. Richard Rhodes' *The Making of the Atomic Bomb* is remarkable in the coherence and craftsmanship of his account, but for all its reputation nevertheless omits pertinent details – the result, perhaps, of too linear a conception of subject.[8] Rhodes is concerned solely with America's pursuit of an atomic bomb, and only when other states' activities impinge directly on that core narrative are they even acknowledged. There is thus no reference made to the laboratories in Montreal and at Chalk River, and little analysis of UK-US-Canada dynamics. Oliphant *is* referenced, however: in common with other histories before and after, a quip attributed to the American physicist Leo Szilard about the significance of 'meddling foreigners' is cited, alongside more prosaic assessments, in support of the argument that Oliphant's personal intervention helped catalyse the American programme.[9]

Although Smyth had prepared the conceptual ground for subsequent America-centric accounts, he cannot really be blamed for them. His account was at least balanced by the content of the accompanying British statement, *Britain and the Atomic Bomb*, which sought to recount the entirety of Britain's experience with nuclear technology and highlight the explicitly British aspects of the joint programme. More so than the American document, the British account emphasized from the outset that 'scientists of many countries shared in this development'.[10] In particular, the British acknowledged the Canadian contribution – although the descriptions of Anglo-Canadian relations were somewhat economical:

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[5] Lorna Arnold, 'A Letter from Oxford: The History of Nuclear History in Britain', *Minerva*, 38 (2000), p.202
[6] Richard G. Hewlett and Oscar E. Anderson, Jr., *A History of the United States Atomic Energy Commission, Volume I: The New World, 1939-1946* (University Park: Pennsylvania State University Press, 1962), see especially pp.ix-x
[7] Ibid.; *cf.* p104, p.202, p.261, p.257, p.272, p.427, p.616
[8] Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon & Schuster: 1986)
[9] Quoted in Rhodes, *The Making of the Atomic Bomb*, p.372; see below, p.54
[10] Smyth, *Atomic Energy for Military Purposes*, p.255

> A proposal was made to the Canadian Government that a joint British-Canadian research establishment should be set up in Canada …. The Canadian Government welcomed the suggestion, with the result that, at the beginning of 1943, a large research establishment was set up in Montreal …. [The enterprise] represents a great contribution, both in men and money, by that government to the development of this new branch of science…[11]

The British statement was nowhere near as fulsome as the American, and its impact was consequently rather more limited. What is significant is the extent to which it, and its Canadian counterpart, reflected an early deviation from the American narrative in terms of interpretive approach. Smyth's account illustrates the tendency in American nuclear historiography to portray the bomb project as overwhelmingly American, aided in limited (albeit significant) respects by allies, but ultimately testifying only to American power and ingenuity. The British statement reflects the emergence of a parallel, officially sanctioned British interpretation of the advent of nuclear weapons, in which swift initial progress by the British, eclipsed eventually by the growing American programme (which Britain had at any rate catalysed), was followed by a joint Anglo-American-Canadian endeavour. This narrative is broader, encompassing the work of the Montreal team as well as the work in the US. It also carries a significant emphasis on wartime expediencies as explanations for major decisions: the winding down of research in Britain in favour of the Canadian-American work is justified explicitly in terms of ensuring the timely delivery of a bomb for wartime use.[12] Such interpretive frameworks are echoed in subsequent British nuclear historiography.

The Canadians, too, released an explanatory statement. Prepared in close co-ordination with the British, and published a day after the American and British documents, it stressed the multi-national nature of the endeavour:

> The dropping of the first atomic bombs is … the culmination of the work of scientists from many nations, the pooling of the scientific and natural resources of the United States, Britain and Canada and the expenditure of hundreds of millions of dollars in the United States and smaller, but substantial, sums in Canada[13]

The Canadian statement is tonally similar to the British in terms of its portrayal of nuclear interactions among the allies. The language with which the body of the Canadian statement addresses the Anglo-Canadian arrangement is as sparing as the British: 'Towards the end of 1942, the British proposed that an important section of the work should be carried on in Canada as a joint enterprise…'. The passage is almost entirely descriptive, rather than analytical, but Canada's privileged information access is nevertheless highlighted.[14] Elsewhere, the nuances of Anglo-Canadian dynamics are more apparent: Canada is portrayed as a 'pioneer' in this new branch of technology and science, and the Dominion government's decision to take over ownership of the country's uranium mines is justified as a step to 'preserve this important asset

[11] Smyth, *Atomic Energy for Military Purposes*, pp.284-285
[12] Ibid., p.287
[13] Smyth, *Atomic Energy for Military Purposes*, p.288
[14] Ibid., p.289

for the people of Canada'.[15] Towards the end of the document, which closes with a full list of the names and affiliations of the scientists involved (both Canadians and 'those from abroad') the Montreal/Chalk River project is referred to, with evident pride, as '[t]he largest and most distinguished group of scientists ever assembled for a single investigation in any British country'.[16] More will be said in due course about the nature of 'British' identity, the extent to which the Dominions could be considered 'British', and the implications for concepts of sovereignty and collaboration. For the present, all that need be noted here is that the Canadian government's initial presentation of its own involvement in the allied nuclear programme relied ultimately on a close identification with, if not the United Kingdom government itself, then at least with a broad cultural-civilizational concept of 'Britishness', whilst simultaneously promoting the idea of a uniquely *Canadian* contribution.

The initial statements were never intended as scholarly history; they were contemporary government releases, serving to inform their interested but largely ignorant populations as to how this paradigm-altering technology had been born. For this reason, though, their impact has been significant: their divergent approaches to presenting the nuclear narrative set the tone for much of the history-writing that would follow. The narrow focus of many American accounts; the awkward balance between pride and exculpation in many British accounts; the aspiration to equality with the allies in many Canadian accounts; all are prefigured to some extent in these summaries of the wartime nuclear experience.

In the decades following the publication of the official accounts, those wishing to write on early nuclear history faced an inevitable paucity of sources. One of the primary purposes of the Smyth Report and its Anglo-Canadian supplements had been to forestall public curiosity by collating the barest facts – an outline of the scope of the project and the fundamental physics upon which it rested – and to present it as the sum total of declassifiable information.[17] In this it largely succeeded: much information, political as well as technical, remained classified. Lack of archival sources could not dissuade writers for long, though; enough information was still in the public domain, or accessible to dogged researchers, for fresh accounts to be written. Representative of these early, unofficial accounts are *The Birth of the Bomb*, a 1961 effort by the British writer Ronald W. Clark, and Robert Jungk's *Brighter than a Thousand Suns* ('*Heller als tausend Sonnen'*).[18] The accuracy of these accounts left plenty to be desired. The authors' only recourse, other than to the sparse and unreliable information then available, was to interviews with the key figures. These certainly had some value, but the passage of twenty years tends to have a deleterious effect on even the sharpest of memories. Clark's roll of interviewees was undoubtedly impressive, but as Hewlett and Anderson pointed out, no level of diligence and authorial skill could counteract reliance on recollections decades old.[19] (Jungk fared worse still: his account was written off as 'hopelessly inaccurate'; an uncharitable assessment, but one which the archival record has subsequently validated.)

Alongside these non-archival histories came the memoirs of key figures. The practice of autobiography is somewhat different from that of history-writing: the dispassion at which historians aim is not available to

[15] Smyth, *Atomic Energy for Military Purposes*, p.289
[16] Ibid., p.295
[17] Hewlett and Anderson, *The New World*, p.407
[18] Ronald W. Clark, *The Birth of the Bomb: The Untold Story of Britain's Part in the Weapon that Changed the World* (London: Phoenix House, 1961); Robert Jungk, *Brighter than a Thousand Suns* (London: Victor Gollancz, 1959)
[19] Hewlett and Anderson, *The New World*, p.657

the autobiographer, whose subject is himself. Since the autobiographer is manifestly concerned for at least some aspect of posterity's view of their contribution, their impulse will inevitably be to exculpate, to embellish, to redirect blame. This propensity is perhaps clearest in the case of Leslie Groves, whose centrality to the Manhattan Project and efforts at *post-facto* reputation-management have had a somewhat distorting effect on subsequent retrospective assessments. The version of events presented in Groves' 1963 memoir, *Now it Can be Told*, although replete with biases and omissions, has been widely adopted;[20] more widely perhaps than is apt. Groves' later biographers have certainly tended to accept their subject's self-interpretation: in a 2002 biography, Groves is portrayed from the outset as 'the indispensable person'.[21]

Other key figures' contributions to the genre achieve rather more restraint; one might cite the physicists Otto Frisch and Rudolf Peierls, whose discursive, anecdote-driven memoirs are each far less self-absorbed than Groves'.[22] It is also interesting to note memoirists' capacity to omit relevant content: the Canadian aspect of the wartime and post-war project is noticeably under-represented even in seemingly relevant memoirs; the most frustrating example is that of the American scientific official James Conant, a key influence on the fate of the Canadian project, who unashamedly glosses over the entirety of his atomic role, instead portraying attitudes towards collaboration with the United Kingdom radically at odds with those which emerge from the archives.[23] Ultimately the impact of memoir (and by extension much biography) on the historiography of the nuclear programmes has been to distort in line with ego. The Grovesian view of British insignificance and perfidy has certainly predominated too long.

Whilst the initial shaping of nuclear narratives may have fallen squarely to American authors – a form of victor's history? – the field was not their exclusive preserve for long. In 1959 the British Government had appointed Margaret Gowing to write an official history of the British programme, and the fruit of her labour, *Britain and Atomic Energy, 1939-1945*, was published in 1964, two years after *The New World*.[24] Necessarily catholic in scope, and thus dense with detail, *Britain and Atomic Energy* was concerned only with Britain's wartime experience, although Gowing always intended future volumes, and a thorough consideration of post-war planning was included in the later chapters. The greatest advantage of Gowing's work, especially over Clark *et al*, was her degree of archival access – her admission into 'virgin territory', with 'sole rights of entry'.[25] Gowing's thoroughgoing approach encompassed every aspect of British wartime nuclear experience, and the book is particularly strong on the diplomatic and strategic calculus by which crucial decisions regarding the Anglo-American-Canadian dynamic were made. In early chapters she ably captures the tensions at the heart of the MAUD deliberations: British hesitancy about relinquishing primacy in nuclear research, the practical barriers to a UK-only programme, and the emerging prospect of a Canada-based project as a form of compromise option. Gowing's recognition of the Canadian angle is not limited to the earlier stages, though the combination of archival access and British focus enabled her to produce by the far the most comprehensive treatment of Anglo-Canadian nuclear dynamics that had yet

[20] Leslie R. Groves, *Now It Can Be Told: The Story of the Manhattan Project* (London: André Deutsch, 1963)
[21] Robert S. Norris, *Racing for the Bomb: General Leslie R. Groves, the Manhattan Project's Indispensable Man* (South Royalton, Vermont: Steerforth Press, 2002), p.x
[22] Otto R. Frisch, *What Little I Remember* (Cambridge: Cambridge University Press, 1979); Rudolf Peierls, *Bird of Passage: Recollections of a Physicist* (Princeton: Princeton University Press, 1985)
[23] James B. Conant, *My Several Lives: Memoirs of a Social Inventor* (New York: Harper & Row, 1970), pp.273, 288
[24] Margaret Gowing, *Britain and Atomic Energy, 1939-1945* (London: Macmillan, 1964)
[25] Arnold, 'A Letter from Oxford', p.205

been attempted. The relationship is addressed directly, meriting its own chapter ('Canada's Part in the Project'). Multiple aspects of Anglo-Canadian nuclear interactions are addressed, including the formal negotiations between the UK and Canadian governments, and the corresponding informal and technical discussions. The Canadians are initially portrayed as having been broadly acquiescent to British requests: their response to the suggestion that the French refugee physicist Hans Halban and his team relocate was apparently 'immediate and enthusiastic'.[26] Gowing goes as far as to praise the 'extraordinary helpfulness' of the Canadians.[27] Such treatment would seem to hint at a reasonably straightforward interpretation of the Anglo-Canadian nuclear relationship, wherein Britain, the senior partner, set the agenda for the pliant junior Dominion, which instinctively complied with any request.

As Gowing's account develops, though, it becomes clear that wartime Canada was not, and could never be, simply a useful adjunct to the United Kingdom. Theirs was a special relationship, certainly, but also, beneath the surface, an increasingly contested one. Gowing never explicitly frames her understanding of the nature of the Anglo-Canadian relationship, but at points she characterizes the dynamic in terms redolent of the Canada-as-mediator model prominent in Canadian historiography.[28] This was true both in positive terms – the Canadian administrator C.J. Mackenzie is described as having been 'very helpful in smoothing relations at the working level' between Britain and the US – and when things were proceeding less smoothly.[29] Gowing is clear that when UK relations with the US were at their worst, so too were Anglo-Canadian relations. Much though the British might have expected it, the Canadians did not simply follow the British lead: Canadian strategic imperatives were separate from (although frequently similar to) those of the mother country. For Canada, the maintenance of friendly relations with the United States was of 'fundamental importance'. Moreover, the Canadians were irritated by British 'obtuseness' – an attitude which Gowing describes as having 'smacked of treachery' for observers in London, where 'an unbroken Anglo-Canadian front' was desired.[30] Apparent here are two key themes: contentiousness around the extent to which Canada was viewed as subordinate to Britain, and the Canadian disposition to seek a constructive, mediating role.[31]

Gowing's handling of Anglo-Canadian relations was undoubtedly more nuanced than that of any previous account. Yet it remains under-developed, resting on implicit assumptions about how the two states interacted and how each perceived its relationship with the other. At times, the relationship is portrayed as straightforward subordination, with Britain the unquestioned superior power. At other points, Canada is treated as though fully sovereign, with a decidedly independent streak. The roots of the paradox – or the explanation for the transition from one state to the other – are never really considered.

Other Dominions meanwhile receive relatively short shrift in *Britain and Atomic Energy*. Personnel from elsewhere in the commonwealth are mentioned, but the mechanisms of their involvement are never addressed, nor are the implications of their engagement with nuclear secrets discussed. Dominion heritage

[26] Arnold, 'A Letter from Oxford', p.188
[27] Ibid., p.189
[28] *cf.* D.R. Owram, 'Canada and the Empire', in Robin W. Winks (Ed.), *The Oxford History of the British Empire Volume V: Historiography* (Oxford: Oxford University Press, 1999)
[29] Gowing, *Britain and Atomic Energy*, p.173
[30] Ibid., pp.196-197
[31] Ibid., p.197

is seldom referenced, and never truly explored. To all intents and purposes, Australians and New Zealanders are counted as 'British'. A case in point: Gowing only mentions Mark Oliphant's Australian heritage on page 315, after more than a dozen prominent references to his involvement in the British and American projects. The only (partial) exception here is for Canadian personnel, owing to the greater analytical attention paid to that relationship and the fact of Canada's privileged position as a named partner in the project.

Britain and Atomic Energy was followed a decade later by *Independence and Deterrence: Britain and Atomic Energy, 1945-1952*, a two-volume treatment of the period from the closing of the Second World War to the successful testing of Britain's first nuclear device. The passage of time may account for the slightly more nuanced understanding of the importance of the Commonwealth evident in these successor volumes (though the fact of Australian involvement in British weapons testing doubtless contributed too). Gowing acknowledges from the outset of the policy-making volume that atomic history is 'woven into' almost every part of Britain's post-war history – 'international, diplomatic, Commonwealth, military, constitutional…'.[32] This recognition permits a slightly more rounded analysis of at least some aspects of Commonwealth (read: Canadian and Australian) nuclear relations with Britain. Much of the analysis here lies outside the chronological scope of this thesis, but what Gowing ably highlights is the essential tension between the impulse to Dominion collaboration and the imperative to secure close and lasting nuclear collaboration with the Americans, which had emerged at a very early stage. Gowing is less concerned for the perspective of the Dominions themselves, but at least addresses Anglo-Canadian relations in some depth. Canada is presented as 'torn' between her ties with Britain and those with the United States. She is also held to have posed a problem for the British: what part would she play in a post-war environment of diminishing US-UK co-operation? And how could the inclusion of Canada – and the concomitant exclusion of the other Dominions – be justified?[33] Gowing points out that Britain continued to derive valuable information from the Canadian project, and that the exchange was essentially reciprocal: 'there was full exchange of almost all material, classified or not, between Harwell and the Canadian project'.[34] The Canadians are shown never to have wavered in their belief that they were given 'cast-iron assurances during the war that Chalk River would be the preliminary to a large joint enterprise in Canada, and that the major British atomic energy development would take place there'.[35] The Canadian cabinet minister C.D. Howe had even hoped 'that the Canadian project would be regarded as the nucleus of the Empire's future atomic effort'.[36] This, of course, never materialized. *Independence and Deterrence* also picks up on the theme, apparent in *Britain and Atomic Energy*, of Canada as a mediating force between Britain and the United States. Canada, apparently, 'could always appreciate much better than the British the viewpoint of her next-door neighbour'.[37] This, too, is a theme this thesis echoes.

Nuclear history since Gowing has benefitted from the gradual (and imperfect) opening of relevant archives to public access. With greater freedom to cite original documents, contemporary historians have been able

[32] Margaret Gowing, *Independence and Deterrence: Britain and Atomic Energy*, *1945-1952,* 2 volumes (London: Macmillan, 1974), *Vol.1, Policy Making,* p.ix.
[33] Ibid., p.9
[34] Gowing, *Independence and Deterrence*, Vol. 1, p.112
[35] Ibid., p.130
[36] Ibid., p.137
[37] Ibid., p.132

to expand the scope of nuclear history pursuing their studies in one of two directions: towards holistic treatments of one major aspect of nuclear history, or towards more in-depth analyses of specific aspects. Both forms trace an inheritance to previous generations – where Britain is in any way in view, the debt to Gowing is almost ineluctable – but both also reflect more recent sensibilities: they generally make scant reference to the Commonwealth as an influence, or indeed a presence, in Britain's nuclear history.

At the more helpful end of the historiographical spectrum lies a useful monograph by Ferenc Morton Szasz, *British Scientists and the Manhattan Project*. Szasz seeks to deal explicitly with the British Mission at Los Alamos, rather than the wider British contribution, and so he has little to say about work conducted at Berkeley, Oak Ridge, or in Canada. His concern is rather with the experience and contribution of the British scientists (around twenty-four of them, 'depending on how one counts') who served at Los Alamos.[38] He nevertheless offers some important analyses, arguing that the British consciously sought to supply a useful contingent to Los Alamos in full cognizance of the likely post-war benefits of exposure to the American-led programme. Szasz also notes, very helpfully, the continuation of a British presence – and influence – in the American programme after the cessation of hostilities, pointing out that five of the British contingent (Bretscher, Mark, Penney, Titterton and Tuck) remained at Los Alamos into 1946, and that the latter three were involved in the Crossroads tests.[39] He further reflects and bolsters the apparent consensus position that revelations as to the scale of Soviet espionage, and especially the extent of Klaus Fuchs' knowledge and subsequent treachery, were the principal factor in blocking future nuclear collaboration.[40] If a criticism must be levelled at this otherwise helpful and self-contained monograph, it is that its narrowness of focus shears it of context. No attention is paid to the experience – very nearly to the *existence* – of British Manhattan Project personnel outside Los Alamos (such as Oliphant's team at Berkeley). There is, as a result, little reference to the wider significance of British nuclear work in North America.

Commonwealth Historiographies, Nuclear and Otherwise

The natural counterbalance to the limited (and often tangential) inclusion of Commonwealth factors in British nuclear historiography is to be sought in the perspectives of Commonwealth historians. Their accounts are no more holistic in their treatment of the issue than their counterparts elsewhere – in some senses they are noticeably more parochial – but they have the advantage of at least treating the dynamic of Dominion engagement with nuclear issues as one of first importance. It would be well, therefore, to consider the various countries' nuclear historiographies in turn, before drawing some preliminary conclusions as to the adequacy or otherwise of the existing literature.

First, though, it should be acknowledged that historical analyses of states' early nuclear interactions with Britain will themselves be conditioned by wider historiographical trends. The interpretive lens through which the historian studies the past is inevitably influenced by their cultural milieu. This is especially evident in imperial history, for here deep historical and cultural legacies conspire with contemporary

[38] Ferenc Morton Szasz, *British Scientists and the Manhattan Project: the Los Alamos Years* (Basingstoke: Macmillan, 1992), p.xix
[39] Ibid., pp.47-48
[40] Ibid., p.85

discourses, such that each generation is shaped by its own experiences with (and attitudes towards) imperialism. These fresh lenses can serve welcome functions in redressing old historiographical injustices, but any process of reduction to a simple narrative, whether traditional or revisionist, invariably carries with it the risk of distortion, as such narratives supersede or mask the complexities of human history. There is in particular a tendency apparent in most of the former Dominions to present narratives of national independence which are overly linear in conception. Projecting backwards from current conditions of full sovereignty, accounts can often be premature in their identification of national distinctiveness, with the result that some sources, events and individuals – those that seem to reflect the progressive development of the nation – are privileged, whilst those that reflect less straightforward understandings of national development are seen as aberrations to be glossed over or explained away.

Several distinctive traits in Canadian and Australian historiography should be acknowledged. First, in Canadian historiography, 'imperial' history has tended to be interpreted narrowly as 'the bilateral study of Canadian-British events',[41] rather than as a more complex set of core-periphery and inter-territorial interactions. Second, Canadian historians have tended to view imperial/Commonwealth dynamics as either secondary to, or at the very least 'augmented' by, the trilateral US-UK-Canadian dynamic.[42] Third, the Second World War is widely portrayed as the significant watershed in Canadian historical development, being held to have marked Canada's transition to effective sovereignty. This image of a country 'coming of age' is widespread. It is found, for example, in J.L. Granatstein's *Canada's War*, which whole-heartedly affirms the wartime-transition narrative ('By 1945 the world was different and Canada with it').[43] Most accounts of Canada's interaction with the British nuclear programme have sought to fit this interpretive frame.

Comparable tropes exist in Australian historiography: linear accounts of Australia's inexorable march to independence and nationhood abound, with the world wars framed as crucial turning points.[44] The excesses of such histories have, however, been countered by more nuanced analyses. Stuart Ward, for example, is dismissive of the tendency in Australian-nationalist historiography to portray the relationship between Britain and Australia in confrontational terms, with Australia seeking always to assert itself and break free from British oppression. This approach, he suggests, forces the historian to view every interaction either as a triumph of nationalist self-assertion, or else as a regrettable failure of will; it ascribes nationalist motives inappropriately, sees conscious conflict where none existed, and generally subordinates the historian's dispassion to his nationalist sentiment.[45] Ward is equally dismissive of historians' propensity to identify 'turning points' in Australian attitudes (the foremost example being the fall of Singapore).[46] He rejects the commonplace idea that Australia's wartime experience signalled (or confirmed) the 'obsolescence' of imperial ties, instead asserting the opposite: that the experience of conflict and vulnerability reinforced the

[41] Owram, 'Canada and the Empire', p.146
[42] David Mackenzie, 'Canada, the North Atlantic Triangle, and the Empire', in Judith M. Brown & W.M. Roger Louis (Eds.), *The Oxford History of the British Empire Volume IV: The Twentieth Century* (Oxford: Oxford University Press, 1999), pp.574, 581-2
[43] J.L. Granatstein, *Canada's War: The Politics of the Mackenzie King Government 1939-1945* (Toronto: University of Toronto Press, 1975/1990), pp.420-421
[44] *cf.* Stuart Macintyre, 'Australia and the Empire', in Robin W. Winks (Ed.), *The Oxford History of the British Empire Volume V: Historiography* (Oxford: Oxford University Press, 1999)
[45] Stuart Ward, *Australia and the British Embrace: The Demise of the Imperial Ideal* (Carlton South, Vic.: Melbourne University Press, 2001), p.6
[46] Ibid., p.13

importance of the imperial relationship. Ward is not alone in having presented such arguments: a chapter by J.D.B. Miller in an earlier historical volume offers a similarly structured critique of nationalist historians' tropes, including that of a straightforward transition from one protecting power (Britain) to another (the United States). Miller rightly allows political actors more nuanced views than those expressed in their speeches: 'filial piety is capable of a variety of expressions'.[47] Unfortunately these helpful admonitions are not universally reflected in Australian *nuclear* historiography.

In spite of Canada's early prominence in nuclear developments, relatively few Canadian historians have sought directly to address Canadian engagement with nuclear weapons in the period of their first development. A journalist, Wilfrid Eggleston, made an early foray (with official imprimatur) into the field, producing, in *Canada's Nuclear Story*, a detailed technical narrative of the first two decades of Canada's nuclear endeavours.[48] Eggleston's account echoes many of the themes present in Gowing's *Britain and Atomic Energy*, which had been published a year earlier, including the sense that British mis-steps in the relationship with America had a concomitant negative effect on the Canadian project (the relevant chapter is titled 'A Promising Partnership Deteriorates'), whilst also accentuating specifically Canadian achievements and emphasising Canada's trajectory towards peaceful nuclear research and development.

More general Canadian diplomatic histories of the wartime and early post-war periods – of which there are several – likewise vary significantly in quality. Two of the stronger are John Holmes' and James Eayrs' accounts, which merit recognition for their nuanced engagement with Canada's nuclear experiences insofar as they influenced the country's foreign affairs.[49] Eayrs also advances the useful concept of Canada having 'grown up allied' as a framework for interpreting Canada's evolving relations with Britain and the United States. Yet their analysis is the exception rather than the rule: most pay scant or no attention to nuclear research, and almost never delve especially deeply into the technical and relational contingencies which ultimately determined the programme's course.

Perhaps the most valuable analysis (being more scholarly than Eggleston, and more technically attuned than Holmes or Eayrs) is Brian Buckley's *Canada's Early Nuclear Policy*.[50] Focusing on the Canadian experience, Buckley nevertheless remains alive to Commonwealth dynamics and pays close attention to the nuances of the trilateral US-UK-Canada relationship. The reader's attention is particularly drawn to the sheer contingency of Canadian policy-making, which is framed as little more than a series of 'adaptive responses' to external circumstances.[51] Useful points are also made about the character of the post-war project as implicitly defence-oriented and the extent to which Canada's wartime experiences and alliance-dependent security context shaped official attitudes. Buckley's close analysis is, however, the exception rather than the rule in later historiography. Other Canadian nuclear histories are chiefly concerned, like Eggleston, with the tracing the origins of the later, peaceful Canadian nuclear industry; they also tend to

[47] J.D.B. Miller, 'An Empire that don't care what you do', in A.F. Madden and W.H. Morris-Jones (Eds.), *Australia and Britain: Studies in a Changing relationship* (London: Frank Cass, 1980), pp.90-91
[48] Wilfrid Eggleston, *Canada's Nuclear Story* (Toronto: Clarke, Irwin and Co., 1965)
[49] John W. Holmes, *The Shaping of Peace: Canada and the Search for World Order, 1943-1957, Vol. 1.* (Toronto: University of Toronto Press, 1979); James Eayrs, *In Defence of Canada: Growing Up Allied* (Toronto: University of Toronto Press, 1965)
[50] Brian Buckley, *Canada's Early Nuclear Policy: Fate, Chance, and Character* (Montreal: McGill-Queens University Press, 2000)
[51] Ibid., p.140

emphasize distinctiveness in the Canadian experience rather than acknowledging commonalities among the allies. This is as apparent in the official histories as in the works of individual historians.[52] There is something of a teleological impulse at work here: the assumption is that since Canada ultimately developed a peaceful independent nuclear programme, the trajectory of Canadian nuclear activity must always have been towards peaceful ends and independence.

Australian nuclear histories are noticeably different in tone. Where Canadian narratives emphasise a trajectory towards independence and peaceful applications, Australian accounts fixate critically on their country's apparent subordination to British interests. The root of this difference would appear to lie in Australia's unique experience as a venue for British nuclear weapons testing. Although the British tests in Australia lie outside the period of this thesis, they have cast an inescapably long historiographical shadow. The 1985 report of the Royal Commission into British nuclear tests in Australia reflected the essentially hostile dynamic of the investigation (as well as the prejudices of its rather combative chairman, Jim McClelland).[53] Capturing something of the anti-nuclear, anti-imperial zeitgeist in his country, McClelland's report proclaimed, as it were *ex cathedra,* that British nuclear testing in Australia, and by extension all Australian interactions with the British nuclear programme, represented an aberrant episode arising out of a regrettable excess of imperial deference on the part of the presiding politicians; this was an unpleasant phase, belonging to a distant past, beyond which Australia had rightly advanced. This nationalist-flavoured teleology underpins most subsequent accounts of Australian nuclear interactions with Britain. The unspoken assumption is that the tests must be accounted for as an act of imperial imposition, and their ultimate disavowal by the Australian people and state must be construed as progress, the abnegation of a previous state of subjugation. A side effect of this is that data-points contrary to this narrative – the centrality of Mark Oliphant and the Australians' persistent early efforts to secure greater involvement in the British programme, for example – risk either being passed over in relative silence, or being explained away as only minimally relevant.

The strengths and weaknesses of this uniquely Australian-influenced pattern of analysis are evident in the works of three prominent historians of Australia's nuclear experiences: Lorna Arnold, a Briton who wrote the official (British) account of UK nuclear weapons trials in Australia; Alice Cawte, an Australian who wrote on Australia's entire atomic history; and Wayne Reynolds, an Australian who has explored several relevant facets of Australian nuclear history as it intersected with British imperial interests.

To address Arnold first: in method, analysis and style her writing demonstrates a significant debt to Margaret Gowing, whom she had assisted in researching and writing *Independence and Deterrence*. The most relevant of her own works, *A Very Special Relationship*, provides the official account of British nuclear tests in Australia.[54] The very name of the book conveys its premise: she explicitly credits the

[52] *e.g. Canada Enters the Nuclear Age: A Technical History of Atomic Energy of Canada Limited*, D.G. Hurst (Ed.) (Montreal: McGill-Queens University Press, 1997); Sean F. Johnston, 'Creating a Canadian Profession: the Nuclear Engineer, c.1940-1968', *Canadian Journal of History,* 44:3 (2010); Sean F. Johnston, 'Security and the Shaping of Identity for Nuclear Specialists', *History and Technology*, 27:2 (2014)
[53] *The Report of the Royal Commission into British Nuclear Tests in Australia* (Canberra: Australian Government Publishing Service, 1985)
[54] Lorna Arnold, *A Very Special Relationship: British Atomic Weapon Trials in Australia* (London: Her Majesty's Stationery Office, 1987)

existence of a 'very special relationship' between Britain and Australia as the enabling factor for UK nuclear tests. Yet somewhat paradoxically for a *British*-government sanctioned account, much of Arnold's analysis sits within a nationalist interpretive framework. The reader learns that British co-operation with Australia on nuclear issues was cursory at best, and that 'the overwhelming desire for a renewed Anglo-American partnership, and the fear of spoiling chances of achieving it, inhibited all Britain's other relationships'.[55] For Arnold, the 'very special relationship' was emphatically that of a senior and junior partner. A work which might notionally have served as a riposte to the Royal Commission's account thus seems uncritically to have adopted its premisses.

Alice Cawte is less conflicted. She judiciously makes early reference to her 'republican leanings' as an influence on her understanding of UK-Australian dynamics, but is sufficiently dispassionate to acknowledge the discrepancy between her starting assumptions – which she outlines – and her eventual interpretation of the archival record.[56] Cawte ably delineates early interactions between Mark Oliphant and the Australian Council for Scientific and Industrial Research (CSIR). She does little, however, to interrogate the assumption that Australian and British interests could be straightforwardly disaggregated. 'The British' remain conceptually 'other' throughout, and Australia is consistently assumed to have only independent interests. Cawte therefore struggles with the temptation to judge decisions retrospectively: at points, her account of Australian nuclear diplomacy seems almost to be highlighting missed opportunities, implicitly suggesting what *should* have been done for the benefit of Australia. Negotiations over co-operation with Britain are depicted either as fitting a straightforward quid-pro-quo framework, or as having failed to do so.[57] Cawte cannot envisage any other dynamic between the two countries. The nearest she gets to a depiction of an alternative or more nuanced dynamic is in describing the Australians as believing in 'an unstated arrangement…intuitive rather than contractual'.[58] Cawte's analysis of Britain's wider post-war security position as it intersected issues of nuclear co-operation is concise and broadly conventional. Taking it as read that the war inflicted an 'immense loss of power' on Britain, she he highlights the tension between Dominion co-operation ('one of the cardinal principles of British defence policy') and the atomic relationship with the United States.[59]

This essentially declinist interpretation of British policy can be profitably contrasted with the thesis advanced by Wayne Reynolds, who addressed the nuclear aspects of the Dominion relationship in a series of articles in the late 1990s, culminating in a monograph, *Australia's Bid for the Atomic Bomb*. Reynolds posits a far more intentional, far more imperial conception of Australian engagement with British nuclear activity. His view is that the co-operation of the Dominions formed a crucial element in British post-war planning, including in the nuclear realm; in short, that Britain and Australia actively sought a 'fourth empire' based on nuclear weapons.

Reynolds' argument, though chiefly concerned with developments outside this thesis' period, touches on issues discussed in the final chapter of this thesis. Although Reynold's body of research contains much of

[55] Arnold, *A Very Special Relationship*, pp.24-25
[56] Alice Cawte, *Atomic Australia, 1944-1990* (Kensington, New South Wales: New South Wales University Press, 1992), p.xi
[57] Cawte, *Atomic Australia*, pp.7, 35, 40
[58] Ibid., p.41
[59] Ibid., p.12

value, there is also much that is contestable. It is, however, important not to err into disproportion, or to reject his arguments out of hand, as some have: a poor critique by Anna Binnie brands Reynolds' thesis as a 'conspiracy theory', refuses to accept any interpretation of Oliphant ('a great Australian') as having ever supported nuclear weapons, and dismisses, almost in passing, the value of any source produced by politicians, on the grounds that they 'are not known for their scientific expertise'.[60] This approach, seemingly driven more by personal prejudice than close engagement with archival sources, is a good example of the approach this thesis seeks to avoid.

New Zealand's nuclear historiography is a less crowded, less contested space than that of its near neighbour, the emergence of New Zealand's strong anti-nuclear culture in the later twentieth century having perhaps served to obscure knowledge of the country's early dalliances with nuclear development. The most valuable treatment of New Zealand's engagement with nuclear issues in the 1940s is Rebecca Priestley's *Mad on Radium: New Zealand in the Atomic Age*.[61] Like Cawte, Priestley is superficially influenced by the contemporary politics of her nation (in this case, supporting New Zealand's contemporary opposition to nuclear weapons) but nevertheless retains sufficient objectivity to provide a useful account of the limited scale of New Zealand involvement in the UK/US programme, which she portrays as grounded, on the part of the New Zealanders, in a combination of the expectation of eventual advantages for New Zealand and an (unelaborated) sense of loyalty to Britain.[62] Much of Priestley's analysis of this period rests in turn on a useful and perceptive article by Ross Galbreath, highlighting New Zealand's 'Rutherford connection' as a (partial) explanation for the country's early engagement with British nuclear work.[63] Galbreath's contention is that the prestige accruing to the New Zealander Ernest Rutherford as the illustrious progenitor of nuclear physics as a discipline, coupled with the personal cross-commonwealth networks which Rutherford fostered in his lengthy career, served to position New Zealand as a natural and effective participant in British nuclear work. A detailed evaluation of the veracity of this concept is one of the subjects of the fifth chapter of this thesis. Here, it suffices simply to note that Priestley and Galbreath both advance conceptions of New Zealand's disproportionately significant contribution as owing to a combination of strong personal networks and an ethos – part latent, part instilled – of assumed compatibility between national/New Zealand and British/imperial interests. There is no particular tendency to emphasise distinctiveness (as per Canada) or to castigate imperial connections (as per Australia).

Regarding South Africa - the least involved of the Dominions in this period – very little has been written, for other than in the context of a thesis such as this there is comparatively little to write. Relevant content is limited to a handful of journal articles, often on tangential issues. A recent paper by Lucky Asuelime on the 'Uranium Politics of Gatekeeping' [sic] does, however, furnish a useful set of insights on British interactions with the Union over uranium resource issues, and presents a strong argument that Britain, cast as the junior partner in the post-war relationship with the United States, sought actively to leverage its

[60] Anna Binnie, 'Australia's Atomic Conspiracy Theory', *Australasian Science*, 22:7 (2001), p.31
[61] Rebecca Priestley, *Mad on Radium: New Zealand in the Atomic Age* (Auckland: Auckland University Press, 2012)
[62] Priestley, *Mad on Radium*, pp.6, 44-46
[63] Ross Galbreath, 'The Rutherford Connection: New Zealand Scientists and the Manhattan and Montreal Projects', *War in History*, 2:3 (1995)

Dominion partners' resources to its own ends – a pattern of behaviour the Union government never endorsed.[64]

Defining the Historiographical Gap

It is evident from this review of the contours of nuclear history that much has been written that is *relevant* to the question of Commonwealth involvement in the British nuclear programme, but that little has been done to address the question directly. That the Commonwealth held at least some significance for nuclear policy-making during and after the war is readily apparent: one need only consider the full involvement of Commonwealth personnel in the programme, the immense scale of the undertaking at Montreal and Chalk River, and – beyond the immediate period of this thesis – the relative ease with which British nuclear trials were arranged in Australia. What is absent in every case is the comparative element: a whole-Commonwealth approach is never enterprised, and tentative recognition of the importance of Commonwealth dynamics never progresses to deeper analysis. Each of these examples has attracted at least passing interest from academic historians, but what is missing is the holistic view, the integrated approach: no attention has been paid to the common thread binding such otherwise disparate topics as the career of Mark Oliphant, the designing of the ZEEP and GLEEP reactors, and the frantic worldwide search for fissile material. The contention at the heart of this thesis is that the Dominion dynamic in its myriad forms acts as the common denominator in these and other instances, and that historical analysis is hampered by the failure to incorporate reference to it. In particular, there has been no effort to produce a narrative of the programme sensitive to the relationships which in some measure underpinned British policy-making. The gap in the historiography is not necessarily vast, but it is substantive: addressing it will enhance historians' understanding of a field which remains undeniably complex.

It is in addressing this neglected factor, then, that this thesis' chief contribution will lie. The thesis rests on two foundational premisses. The first is that the known involvement of Commonwealth personnel in the programme is a phenomenon meriting explication. The second is that the Commonwealth existed as an influence on British strategic thought and as a daily reality for thousands of British and Commonwealth citizens. The impact of these phenomena on the British nuclear weapons programme consequently merits assessment. The question guiding this thesis can be therefore be cast as follows: *What was the significance of the Dominions' interactions with British nuclear research and development work in the pursuit of nuclear weapons by the United Kingdom (a) for the United Kingdom itself, and (b) for the Dominions, individually and corporately?*

[64] Lucky Asuelime, 'Uranium Politics of Gatekeeping: Revisiting the British Government's Policy vis-à-vis South Africa, 1945-1951', *Historia*, 58:1 (2013)

The Task and the Tools

How then to proceed? The task is clear enough: attention must be paid to the previously neglected aspects of early British nuclear history represented by the concept of Commonwealth, through a thorough reconsideration of each stage of that history. The principal tool for achieving this must be exhaustive archival work: the mode of analysis is to be the close reading and explication of archival material, illumined by (and in conversation with) existing scholarship. Accounts which are concerned only with exchanges between statesmen –manifesting in infrequent messages, and even rarer meetings, between Prime Ministers and Presidents – necessarily overlook these lower strata, and thereby miss crucial detail, for in scientific diplomacy, perhaps more so than in other forms, the parameters for interaction are set largely at the operational, rather than the executive level. To achieve exhaustiveness in archival work requires consciously pressing beyond the level of ministerial and prime-ministerial decision-making to the strata where scientists and civil servants themselves engaged with the questions at hand – for it is here, arguably, that the true substance of nuclear history will be found to lie.

It is important to note, however, that this thesis is not primarily concerned with the study of previously unknown (or even especially underutilised) archives: the vast majority of the materials consulted here *have* been accessed by historians, including several whose works are referenced in the discussions above. The innovation here instead lies in the angle of attack. The intention is to approach the material with a greater degree of sensitivity to Commonwealth dynamics than is reflected in existing accounts – not in order to impose Commonwealth interpretations where there are none, but rather to detect the presence of Commonwealth interactions where these have been ignored. Such an approach is entirely in line with this thesis' working hypothesis that the Commonwealth played a more significant role in the UK nuclear weapons programme than has previously been acknowledged.

The source terrain for this thesis is vast and by definition multi-national. Myriad official papers relating to the MAUD Committee, Tube Alloys, and the post-war project are held by the National Archive and were, until December 2018, freely accessible.[65] The National Archive's papers relating to Tube Alloys and the early years of British nuclear activity – which form the greater part of the mass of primary sources consulted for this thesis – fill several hundred files, covering every aspect of policy, administration and technical deliberation. Multiple government departments were involved in the nuclear project at various stages, and this is reflected in the wide distribution of relevant content: there is the 'AB' file series, relating to the United Kingdom Atomic Energy Authority and its predecessors, the 'PREM' and 'CAB' series, comprising materials associated with the Prime Minister's office and the Cabinet, and myriad smaller clusters of files in series relating to the predecessors of the Foreign and Commonwealth Office, the erstwhile Ministry of Supply, and various branches of the British security and intelligence apparatus. In each case, files and papers are arranged along primarily administrative lines, a set-up somewhat inimical to the straightforward identification of sources relevant to a thematic thesis. This distribution of material across a multitude of files has the effect of diluting the various 'signals' for which the researcher is searching in reams upon reams of 'noise'. This, indeed, may help explain why important but less immediately prominent aspects of

[65] See bibliography for a fuller explanation

the UK nuclear programme (including, if this thesis' hypothesis is correct, the involvement of the Dominions) have thus far been overlooked by historians.

Other sources of relevance exist elsewhere in the Commonwealth. Significant overlap between the contents of the various national archives could be posited, but not taken for granted, so materials from Canada, Australia and New Zealand were consulted. Papers relating to the Canadian project, and Canadian nuclear policy in general, are held by Library and Archives Canada; here, too, the distribution of material proved inimical to speedy research. Materials on wartime and post-war nuclear research and development are held in the National Archives of Australia at Canberra, and in New Zealand by Archives New Zealand; in both cases there is valuable material on the countries' experiences of engaging directly and indirectly with the British nuclear project. Meanwhile the immense volumes of material generated in the United States were *not* consulted: the British and Commonwealth protagonists of this thesis did not possess the luxury of knowing the Americans' secret counsels, and to have delved too deeply into the American archives would have been to imperil the thesis' Commonwealth focus.

Regarding the sources themselves, there are several broad classes of useful material. Minutes, memoranda and technical documents help trace the formal progress of the UK programme through its various stages, as well as to determine the roles played by specific individuals and to track the officially sanctioned flow of information. The MAUD Committee papers and those of the Tube Alloys organisation are particularly valuable in this regard. Files of correspondence, meanwhile, serve multiple useful purposes. Formal correspondence serves much the same function as memoranda and minutes, in delineating official positions and anchoring the factual account. Some forms of correspondence do, however, offer far greater levels of insight. Broadly speaking, the less official the purpose, or the warmer the personal relationship, the more likely it is that a set of letters will reflect an individual's private opinions. The less guarded nature of some correspondence can also indicate possible informal means of decision-making and information transmission (Mark Oliphant's particular culpability in this respect is discussed in later chapters). These two source-types form the foundation for much of the research here.

Several other comments on the scope and parameters of the thesis are in order. In determining the precise period to be covered, it was felt necessary to resist the temptation to use a nuclear explosion as the endpoint of the narrative. To conclude with Trinity, Hiroshima or Nagasaki would be to conclude too early, for the nuclear bureaucracies' transitions from war to peace are hugely illuminating. Yet to extend the thesis to the first British test in 1952 would draw in myriad additional concerns (including Cold War geopolitics and masses of technical discussion). The nuclear decision of January 1947 is a convenient middle-ground between these two milestones, and serves as an appropriate book-end, since it represents the end of the United Kingdom's 'early' nuclear history and the commencement of a qualitatively new phase in its relationship with nuclear weapons.

Bounds must likewise be set on the countries to be considered under the umbrella of the terms 'empire', 'commonwealth', and 'dominion'. 'Empire' and 'commonwealth' were to some extent interchangeable terms (and in this period were sometimes combined) but carried different emphases: the former was redolent of colonialism and direct rule from London, whilst the latter (somewhat self-consciously) posited

a freer association, echoing Seeley's concept of 'Greater Britain'. The label 'dominion' interfaced more naturally with the ideal of 'commonwealth', therefore, since it, too, reflected the idea of a progression beyond British control. Dominionhood was a constitutionally fluid status, shaped but not fixed by the 1926 Balfour Declaration and the 1931 Statute of Westminster, but also reflecting deep-seated (and often poorly articulated) concepts as to the bounds of Britishness and the extent to which the empire-commonwealth (or at least its white anglophone subjects) formed a single nation. Dominionhood is therefore understood here in terms that would have been familiar to this thesis' subjects, as a status that was part constitutional, part-psychological. The web of relationships between Britain and the Dominions, and between the individuals who lived in them, shaped attitudes on a foundational level, determining who was 'British' and who was 'foreign'; who could be trusted and who could not; who could be expected to be co-operative and who would look only to their own interests. Such concepts were, in a sense, so grounded in culture as to be invisible to those within that cultural setting. The human subjects of this thesis could be powerfully guided by their understanding of 'Commonwealth' without ever making it explicit. There is certainly little reason to expect concise definitions and qualifications in the sources consulted. The work of analysis must therefore, in some instances, be interpretive. Moreover anomalies abounded. In this period Éire and Newfoundland were Dominions in name only, the former having forsworn any connection with Britain, the latter having had to accept a Commission of Government in consequence of the Great Depression. India, Pakistan and Ceylon (Sri Lanka) would not attain to Dominionhood until after the period of this thesis – though the anomalous position of the Raj earns it some reference in the pages that follow. Southern Rhodesia possessed some of the features of a Dominion, without having formally attained the position. In effect, then, the thesis is concerned with Canada, Australia, New Zealand and South Africa – the oldest, most firmly established of the Dominions – whose standing as so-called 'white settler colonies' had granted their (white) populations the status of British subjects, legally indistinguishable from their counterparts in the United Kingdom. Colonial territories – those administered directly from London, with no or restricted capacity for self-determination – lie outside the ambit of the thesis, save where referenced for comparison, or as part of a wider discussion of imperial dynamics.

No claim is made to comprehensiveness beyond these narrow bounds of period and scope. For example, French engagement with the British nuclear project is considered only where directly relevant to this thesis' interests, or else to provide a contrast with the Dominions' experiences – a shame, for it is a subject meriting closer attention. Nor has direct reference been made to American perspectives on Dominion interactions with allied nuclear endeavours, save as these were guessed at or interpolated by British or Dominion observers, for whom America was an entity to be dealt with, whose whims were to some extent opaque and whose policy-making was inscrutable. Here, too, there is space for much profitable archival work: American policy-makers' perspectives on the British empire remain largely opaque.

Finally, whilst a key contention of this thesis is that histories composed of monolithic statements of a nation's policy are hopelessly reductive, the emergence of cliques and caucuses is a perennial feature of government and bureaucracy, and it is appropriate sometimes to identify the commonalities upon which institutions, or factions within institutions, rested.[66] If there is an official mind of imperialism, there is

[66] See also Steven Flank, 'Exploding the Black Box: The Historical Sociology of Nuclear Proliferation', *Security Studies,* 3:2 (1993)

perhaps also a scientific mind. Some measure of synecdoche is therefore unavoidable. References to states – 'the British', 'the Americans', 'the Canadians' – should thus be taken as convenient abbreviations for the collective policy-making apparatus (in the British cases, the MAUD committee, Tube Alloys, *etc.*), reflecting a plurality of interests, whose varying perspectives are acknowledged throughout the text.

The Thesis

The underlying intention of this thesis is to contribute usefully to historians' understanding of the early development of the British nuclear programme and of the processes by which nuclear knowledge and capabilities did (and did not) permeate the British Commonwealth. The thesis itself is arranged chronologically, proceeding from the outbreak of war in 1939 to Attlee's formal decision in January 1947 that Britain would proceed with a nuclear weapons programme (though part of the underlying argument here is that this decision had, in fact, been made in principle far earlier). The chapters themselves are, however, thematic, addressing key issues analytically within a broad narrative framework.

The first chapter is concerned with the initial conditions governing the British nuclear programme. As well as providing an enhanced narrative of the formation and deliberations of the MAUD Committee, it draws attention to the processes by which UK-based personnel from the Dominions enjoyed implicit trust and were able to participate in secret scientific research as freely as Britons, in contrast with allied and émigré scientists, who were treated with a great deal more suspicion. The chapter proceeds to identify early nuclear interactions with Canada, traces the first emergence of the idea that some or all of the British work might be transferred to North America, and emphasises the early significance of the Australian physicist Mark Oliphant.

The second chapter covers the period in which the centre of gravity of nuclear research shifted, seemingly inexorably, across the Atlantic. It traces the implementation of the MAUD report's recommendations and the corresponding intensification of Anglo-American interactions on issues concerning nuclear fission. The chapter outlines the challenges inherent in this relationship, and in realising large-scale work whilst retaining influence *vis-à-vis* the Americans, and identifies the factors which led the British to embrace the idea of a laboratory in Canada as a means of leveraging the Americans towards collaboration in other fields.

The third chapter discusses the crisis precipitated in January 1943 by the imposition by the Americans of new terms for collaboration. The chapter analyses British and Canadian efforts to ameliorate these conditions, exploring the processes by which British officials sought to reassess their position whilst also considering uniquely Canadian perspectives. These trilateral interactions culminated, after a tortuous diplomatic effort, in the Quebec Agreement of August 1943, a reconsideration of which concludes the chapter.

The fourth chapter considers the course of the Canadian project after the Quebec Agreement. It is shown that Quebec in itself did not settle the question of Anglo-American-Canadian co-operation, and that it was only after a further round of negotiations that a consensus was reached and large-scale work in Canada began. The post-Quebec process of discussion is seen to have encompassed thorny questions about

leadership, and to have prompted the British to think seriously about the relationship with Canada and the wider ramifications of collaboration with the Americans and Canadians. The chapter concludes with an analysis of the late-war tripartite nuclear relationship in practice.

The fifth chapter covers broadly the same late-war period as chapter four, but addresses the experience of the other Dominions, who from this point onwards were able to interact increasingly directly with British nuclear work, including through the United Kingdom contributions to the Manhattan Project. Close attention is paid to the processes by which Australia and New Zealand both sought to position personnel within the British programme: their differing experiences are instructive. The chapter also evaluates British efforts to leverage Commonwealth connections in support of resource acquisition.

The sixth chapter is concerned with post-war planning. It traces British efforts to reconfigure wartime expectations to suit the new conditions prevailing in the post-war world, and assesses the extent to which it was hoped that the Dominions might figure within these new plans. The chapter addresses immediate post-war uncertainties around the future of the Chalk River research establishment, portraying a period of awkward readjustments in the Anglo-Canadian nuclear relationship. The chapter lastly considers the processes by which Britain sought, hesitantly, to articulate a more conscious policy of Commonwealth collaboration, and closes at the moment when the UK government formally committed to the pursuit of a nuclear weapon – a decision which, it is argued, had been made in principal many years previously, as much by instinct as by intent.

The essential contention of this thesis is that existing accounts have paid insufficient attention to the role of the Commonwealth in shaping the development of the UK nuclear weapons programme in its earliest stages, and that this omission slightly distorts historical understanding. This thesis therefore seeks to redress the balance, by stressing the fact that the gradual, piecemeal emergence of nuclear knowledge meant that the Dominions – or at the very least Dominion personnel and capabilities – became integral to the UK nuclear weapons programme more or less organically. The habitual assimilation of Dominion subjects into British society, and the wartime integration of Dominion personnel into the British war effort, ensured that neither the programme nor the secret could be kept exclusively 'British'. As the bomb's viability and destructive potential dawned on officialdom, it became abundantly clear that a degree of restraint was required, and that sensitive information on nuclear issues ought not to be transmitted beyond the bounds of necessity; yet the borders of knowledge were always porous. Though there was no need at this stage for any Dominion other than Canada to be brought formally within the nuclear pale, the message still spread. Through Oliphant and others, the Dominion governments learnt that nuclear weapons seemed viable, and that Britain was working on them. Whether it had been by accident or design, those who became privy to the nuclear secret did what they could to capitalise, motivated by a combination of national self-interest and willingness to support the Britain in a potentially war-winning endeavour.

As the nuclear centre of gravity shifted westward, the particular importance of Canada increased. With the American future of the project now assured, leveraging of the Canadian connection became a key instrument of British nuclear policy. Canada's location – immune to bombing, near to the US – and its ability to provide technical and financial support meant that Britain was able to retain close links with the

by now American-dominated programme (and, crucially for the post-war programme, to keep near pace with American research). The Montreal Laboratory and the smaller British missions in direct support of the Manhattan Project were jointly able to keep Britain in the nuclear game. Scientists from across the Dominions played a crucial role: witness particularly Oliphant's work with Ernest Lawrence at Berkeley and Oak Ridge, and Charles Watson Munro and his fellow New Zealanders' work on reactor designs in Canada. Little of this was accidental. Efforts to include Dominion personnel were in many instances acts of conscious policy by the Dominions themselves – or by others acting on their behalf. A key case here is Mark Oliphant's effort to ensure that at least a handful of Australian personnel could take part in the programme, in order to gain exposure to the concepts and technologies involved. Then, as the war drew to a close, with Allied victory and American possession of a deployable bomb both increasingly certain, the prospect of a radically different post-war order began to shape thinking. For Britain, there was a haphazard and only partially conscious effort to repatriate the knowledge gleaned by participation in the (by now emphatically American) nuclear programme, and to envisage a route forward for Britain and her global (/imperial) interests. The process revealed the tension at the heart of Britain's post-war nuclear policy-making. Britain hoped, on grounds of both well-established imperial instinct and geostrategic pragmatism, to incorporate the Dominions into its atomic defence plans, yet Britain could not escape from the new strategic reality: the United States possessed the bomb, the power, and thus the ascendancy. The view from Whitehall was that Britain needed above all to retain a functioning nuclear relationship with the greater power. Such a relationship was incompatible with Commonwealth dynamics as practiced and envisaged from Whitehall. The Americans would never stand for it. This reality came ultimately to overshadow all other factors in British policy formation – including all the old strategies of empire – throughout the long decades of the Cold War.

Chapter One:
The Earliest Stages

This chapter is concerned with the earliest origins of the UK nuclear programme. It covers the two-and-a-half-year period from early 1939, when the concept of the fission-based weapon was yet undefined and its viability unproven, to the completion and dissemination of the final MAUD Committee report in the summer and early autumn of 1941, by which stage it had become abundantly clear that nuclear weapons research merited whole-hearted pursuit. In this brief period the idea of a nuclear weapon passed from the realm of abstract supposition, publicly doubted by most physicists, to a place in the first rank of British wartime priorities. The process by which this transition took place merits close attention. The chapter's function is essentially preparatory: it serves to introduce and contextualise some of the key phenomena in the history of Commonwealth engagement with the British nuclear programme. Subsequent chapters will build on the foundations laid here, tracing the thread of Commonwealth dynamics from their emergence as default assumptions and instinctive responses to their acme as a central influence on the UK nuclear programme.

As nuclear issues began their (initially slow, then increasingly rapid) ascent of the UK government's priorities list, a host of pressing issues emerged. These were questions demanding immediate, and therefore instinctive, answers. How best should Britain seek to explore the emerging nuclear opportunity? What sort of person could be trusted with the secrets of this promising new technology? As the balance began to shift from scepticism to belief, the questions became ever more urgent. Where should development work be undertaken, and by whom? How should it be funded? Where might the men and materials be found for such an endeavour, in a wartime economy, on a blitzed and vulnerable island? Might it not be better to seek partners overseas? If so, with whom could Britain hope to partner? More vital still, whom could Britain trust? And perhaps already at the backs of some of the more percipient minds, that most existential question: what might an atomic world look like for Britain and her interests?

Each of these questions, and the mode of their answering, intersects, in one form or another, with the question of Commonwealth dynamics. Levels of trust accorded to individuals depended on their national backgrounds; dissemination of information and plans for collaboration were shaped by Commonwealth ties. The purpose of this chapter is to illustrate the extent to which the Commonwealth figured in British thinking during the 'emergent' phase of the nuclear weapons project, and, moreover, to ask how conscious a process the varying forms of Dominion involvement really were. This goal is pursued through four stages. First, consideration is given to the initial conditions from which the UK nuclear programme emerged. Here, the primary focus is on the different experiences of émigré personnel on the one hand, and British and Dominion scientists on the other. The next section presents a narrative of the first, faltering efforts of the MAUD committee to comprehend the scope and implications of the uranium question, and to articulate an adequate institutional response. This naturally demanded engagement with potential partners outside the United Kingdom – the first and most prominent of which is shown to have been Canada, rather than the

United States. This section on early contacts is concerned primarily with questions of materials and knowledge transfer. The next section has in view the weightier matter of where in the world a nuclear development programme should be based. The actual transfer across the Atlantic of the bulk of the work, along with much of the initiative, is the proper subject of Chapter Two, but attention here is paid to the question of *when* and *how* the idea first arose. Here, again, Canada is seen to have been more prominent in policy-makers' thinking than is often implied in the literature. Finally, a close examination of the role of Mark Oliphant highlights and clarifies his significance as an early influence on the UK programme and more widely, as well as amply demonstrating the potential for individuals from the Dominions to exercise a decisive influence over policy in the United Kingdom.

Initial Conditions

There is no space for teleology in the history of nuclear weapons. A wartime atomic programme was not inevitable, in Britain or elsewhere, but rather was contingent on myriad minor judgements of viability, priority and strategic imperative. The watchword for this period in British nuclear history should therefore be *uncertainty*: uncertainty as to whether the known phenomena around nuclear fission really had any possible military application, and uncertainty also as to the extent of enemy progress in answering that question. Decisions were made with limited information, in response to emerging evidence, in conditions of secrecy and fear. There was no blank-slate moment for project design: the men setting the direction of the programme had to craft it from existing structures, physical and psychological, in the face of conflicting concerns and competing priorities. If this thesis is to achieve its goal of analysing Commonwealth involvement in the British nuclear programme, it is important to begin by defining the initial conditions – that is, by describing the context from which the UK nuclear programme emerged. This must encompass both an overview of the state of weapons-relevant nuclear physics research at the outset of the war *and* a discussion of particular relevant characteristics of the initial research; namely, that the personnel involved were not solely British, but instead had varied origins, and that the dynamic by which Dominion personnel participated was from the outset distinct from that applying to other nationalities.

To describe fully the rapid advancement of nuclear physics in the late 1930s would be the work of several volumes, but the features salient to this thesis are, mercifully, easily outlined.[67] The three great loci of nuclear physics research in the in the 1930s were Britain, America, and mainland Europe. Throughout the decade, distributed across a dominant handful of laboratories, and connected by a close international network of collaboration, transparency and peer-review, physicists made rapid progress in their analyses of the structure of the atom and the phenomenon of radioactivity. Building on foundations laid by the previous generation of experimentalists (above all, by the New Zealander Ernest Rutherford) a succession of discoveries each suggested further possibilities for research. In 1932 James Chadwick discovered the neutron, which almost immediately earned him the Nobel Prize. The same year, John Cockcroft and Ernest Walton 'split' the nucleus. Around the world, teams of physicists sought to emulate these breakthroughs, and much useful data was obtained. This rapid pace of discovery further accelerated in the twilight months

[67] Gowing, *Britain and Atomic Energy,* opens with a good chapter-length précis.

of European peace. Otto Hahn in Berlin produced a set of startling results regarding the neutron bombardment of uranium, which Lise Meitner and Otto Frisch were then able to interpret theoretically.[68] Their concept of uranium fission (so named by Frisch) suggested that the liberation of vast amounts of energy would be possible, if only a chain reaction of neutron fission could be produced. This was a dreadful prospect: the immense energetic potential of the atom had long been known in physics, but the prospect of its actual release at human instigation had for decades been predicted only in science fiction. Now, for the first time, the weaponization of nuclear physics had become a realistic prospect. Yet there remained a limiting factor: it had also been proven that only the isotope U-235, which comprises less than one per cent of natural uranium, was fissile. It therefore appeared that a chain reaction of sufficient rapidity could not, in fact, be produced. It was a straw at which many fearful physicists would clutch in the coming months.

War intervened at a crucial moment in this rapid scientific advance. A progression to fully-fledged nuclear breakthrough was not at this point inevitable (there remained several theoretical and experimental hurdles to be cleared) but the possibilities inherent in uranium fission had begun to emerge. These advances had, until 1939 (and later, in some contexts) been public: physics in the 1930s, as now, was an essentially open system, with findings shared freely and reflexively through dedicated journals, conferences, and myriad interpersonal contacts. Britain, France and Germany can all therefore be said to have entered the war with the same essential data, and the same tantalising possibilities, plural, in (distant) view. Yet as the fog of war descended, the collegiality of pre-war science was lost: the major players in physics could no longer rely on access to, or even knowledge of, the findings of others outside their own immediate communities. The previously free exchange of ideas could not be sustained, and for most of the European nuclear physicists there must now be other, more immediate priorities: survival for some, war-work for others. Yet the final pieces of the theoretical puzzle had already fallen, almost unnoticed, into place. All that remained was for someone within the (admittedly somewhat distracted) fraternity of physics to alight on, and pursue, the correct line of enquiry.

This ultimately occurred in Birmingham, in the first few months of 1940. Otto Frisch and Rudolf Peierls, both rendered effective exiles from Nazi Germany by dint of their Jewish descent, had each been invited to join the Physics Department at Birmingham by its ambitious new Professor, Mark Oliphant.[69] Together, informally, they were able to make the final conceptual leap: as they discussed a range of hypotheticals, they realised that if the proportion of U-235 could be sufficiently enhanced, the critical mass required for supercriticality (that is, an exponentially increasing sequence of fission reactions, leading to an explosion) would be on the order of kilograms – which in turn implied that a uranium fission device might be realisable as a deliverable weapon. This was information of potentially war-shaping significance, as Frisch and Peierls were immediately conscious. The usual procedure for such a breakthrough in physics – immediate publication and widespread dissemination – was impossible. Yet the two physicists still felt that the

[68] O. Hahn, F. Strassmann, 'Uber den Nachweis und das Verhalten der bei der Bestrahlung des Urans mittels Neutronen entstehenden Erdalkalimetalle', *Naturwissenschaften,* 27:1 (1939); Lise Meitner, O.R. Frisch, 'Disintegration of Uranium by Neutrons: a New Type of Nuclear Reaction', *Nature*, 143 (1939); O.R. Frisch 'Physical Evidence for the Division of Heavy Nuclei under Neutron Bombardment', *Nature*, 143 (1939). A French team under Frédéric Joliot independently achieved the same results within a few weeks: H. Halban, F. Joliot, L. Kowarski, 'Number of Neutrons Liberated in the Nuclear Fission of Uranium', *Nature*, 143 (1939).
[69] Peierls, *Bird of Passage*, p.127; Frisch, *What Little I Remember*, p.120

information must be shared in at least some quarters. It was, wrote Peierls, 'our duty to inform the British government of this possibility', though this must be done subtly: it would not be well to draw attention to their idea.[70]

They therefore went 'to talk it over with Oliphant'.[71] Much more will be said in due course about Mark Oliphant's own, significant contribution to British nuclear history; at this point it is sufficient to note not only that the first two individuals in Britain to recognise the pathway to an atomic weapon were both considered 'enemy aliens', but that the third, Oliphant, was not unambiguously British either: he was, by birth and education, Australian. He was, however, a natural choice of confidant: a senior colleague and proven friend to both men, Oliphant was also known already to be engaged in secretive war work for the British government.[72] He would know how to access the appropriate channels for passing on information, whereas by their own admission Frisch and Peierls 'did not know how to send a secret communication, or, for that matter, where to send it'.[73] Frisch and Peierls thus committed their reasoning to paper for onward transmittal via Oliphant, their instinct for secrecy stretching as far as to have Peierls type up the memorandum himself. Only a single carbon copy was made.[74] Frisch and Peierls' analysis was brief and entirely to the point: in two sections – a technical discussion, and a more accessible set of explanatory and policy-oriented comments – they explained the basic principle of the bomb and the necessity of enrichment (an obstacle they considered 'by no means insuperable'). The potential cost was described as 'not prohibitive'. It was understood that the resulting explosion would 'probably cover the centre of a big city'. Mass casualties were therefore in view – Frisch and Peierls were entirely upfront about the fact that 'the bomb could probably not be used without killing large numbers of civilians'. Indeed, if viable, 'the super-bomb would be practically irresistible'. Most troublingly, they presented an assessment of possible German capabilities in the area:

> We have no information that the same idea has also occurred to other scientists but since all the theoretical data bearing on this problem are published, it is quite conceivable that Germany is, in fact, developing this weapon[75]

In the face of such grave uncertainty, the call to action was unavoidable: 'immediate steps should be taken'. Oliphant seems immediately to have recognized the significance and soundness of the memorandum. He passed it on to Sir Henry Tizard, Chairman of the Air Ministry's Committee for the Scientific Survey of Air Warfare, vouching for his protégés' scientific reasoning and amplifying their call for immediate action. From Tizard came the inevitable bureaucratic response: a committee should be formed. It was, however, to be a small committee, to assemble soon; its task would be 'to advise what ought to be done, who should do it, and where it should be done'.[76] Oliphant was to be a founding member; Frisch and Peierls were not invited. In this committee, which would later be named MAUD, the later UK nuclear programme had its genesis.

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[70] Peierls, *Bird of Passage*, p.154
[71] Frisch, *What Little I Remember*, p.127
[72] *viz*. developing the cavity magnetron
[73] Peierls, *Bird of Passage*, p.155
[74] Ibid., pp.154-155
[75] Frisch-Peierls Memorandum; *cf.* Gowing, *Britain and Atomic Energy* for full text.
[76] Ronald W. Clark, *Tizard* (London: Methuen, 1965), p.218

This bare-bones narrative corresponds with that to be found in the majority of the literature. It is not, however, the complete story. The progression of nuclear physics in 1939 had not gone wholly unnoticed by government. Throughout 1939, the emerging possibilities were, as a later summary for the Prime Minister put it, 'widely discussed' among scientists, many of whom had strong ties with the various interested government ministries.[77] The physicist A.M. Tyndall, of Bristol, had prepared a report in the May of 1939, addressing 'The Possibility of Producing an Atomic Bomb'.[78] This was a remarkably prescient analysis for so early a date, containing as it did speculations about the mechanism of chain reaction, the industrial potential of a moderated reaction, and the likelihood that only a particular isotope of uranium might prove fissionable. Tyndall's conclusion was that existing experimental programmes should be closely watched, and if necessary encouraged financially – a responsibility that fell to the Committee on the Scientific Survey of Air Defence, with the Air Ministry as the financially responsible department.[79] Nor was this the only prod. A group of concerned scientists in Cambridge had even approached their MP – though this action led to little more than a brief meeting with Tizard and agreement to make 'discreet soundings' in Belgium as to uranium sources there.[80] That such discussions had borne little practical fruit was evident from the desultory official efforts made in subsequent months. By July 1939 the government had secured a (small) supply of uranium oxide, and the physicist G.P. Thomson had begun performing funded experiments at Imperial College, but there was no real sense that any further steps needed to be taken (for example, to close down international uranium supplies). Rather, it was felt that 'the position is satisfactory… all that requires to be done is being done'.[81] The experimental results had thus far been inconclusive, bordering on discouraging,[82] but various scientists – including the eminent James Chadwick – were nevertheless conducting preliminary, exploratory work, with official cognisance, in laboratories around the country.

Acknowledgement of this early exploratory work modifies, but need not overrule, the narrative around the origins of the MAUD Committee. The lack of urgency evident in the pre-war period, which carried over into early 1940, certainly reflected a degree of complacency, but also stemmed from the burden of conflicting priorities. The British scientific establishment had more pressing concerns, and compared with the tangible promise of radar the realm of nuclear fission still seemed abstract and speculative. In a time of such uncertainty, little more could be spared for nuclear science than a watchful eye. The significance of Frisch and Peierls' memorandum was not in its having spontaneously inspired the British programme, but lay rather in the fact that their solid theoretical advance came swiftly to the attention of an apparatus which, in its own languid way, had been looking out for such a sign. Their memorandum should therefore be understood to have catalysed, rather than strictly precipitated, Britain's wartime nuclear research.

Frisch and Peierls' experience as émigré also highlights crucial aspects of the construction of British networks of trust. The emergence of uranium fission as an alternative to radar in claiming physicists'

[77] 'T.A. Diary of Events', c.1943, PREM 3/139/9 (TNA)
[78] 'The Possibility of Producing an Atomic Bomb: A Review of the Position', 3rd May 1939, AB 1/9 (TNA)
[79] Ismay to Pye, 15th May 1939, AB 1/37 (TNA). The Committee on the Scientific Survey of Air *Defence* was the immediate predecessor of the Committee for the Scientific Survey of Air *Warfare*; the former became the latter in September 1939.
[80] 'Uranium: History of Action up to 10 May 1939', AB 1/37 (TNA)
[81] Pye to Elliot, 6th July 1939, AB 1/37 (TNA)
[82] 'Outline of the Development of the British T.A. Project', undated, AB 1/631 (TNA)

national priorities precipitated a manpower crisis. Uranium's transition from marginal curiosity to state secret was swift, and the requirement for trusted personnel was immediate. Yet trust was in understandably short supply in wartime Britain, and enemy aliens – even those with an obvious antipathy to Nazism – were the natural focus of popular suspicion and official sanction. The foreign authors of the catalysing memorandum could not, therefore, be called upon to deliberate its implications. Worse still, they might yet be detained as security threats. Frisch was especially vulnerable: unlike Peierls, he had not been naturalised before the outbreak of war and was therefore, in the worst-case scenario, at risk of internment for the duration.[83] Neither scientist had been permitted to work on radar, despite the fact that Oliphant and his team at Birmingham were hard at work on improving the British equipment; they were banned even from the building where the work was taking place.[84] That said, the bounds of secrecy at Birmingham were far from absolute (it was, in Frisch's words, 'a bit of a charade').[85] Oliphant would sometimes go so far as to ask Peierls 'hypothetical' questions, which Peierls would then set out to solve for him. Both men knew what purposes those calculations could serve; neither let on. This liminal existence – personally trusted by Oliphant, and presumably others, but officially excluded from secret work – could hardly be reconciled with the sudden importance their memorandum gave them.

Secrecy, though, was the default position: a message reached Frisch and Peierls, via Oliphant, informing them that whilst the authorities were grateful for the memorandum, 'as actual or former "enemy aliens" we would not be told any more about it'.[86] Frisch and Peierls' input was not desired in anything other than trivial, arms-length forms. This, thought Frisch, was 'obviously inefficient'.[87] Peierls made representations, via Oliphant, to the unknown chairman of the new committee, appealing directly to the national interest, rather than dwelling on any perceived slight, and hoping soon to be cleared to join the discussions.[88] This was what ultimately transpired: cleared by intelligence in June 1940, after three months of background checks, Frisch and Peierls were granted membership of the newly-formed technical committee (but not its policy-oriented counterpart).[89] Even with such accommodations, however, it can hardly be said that these two scientists' early engagement with the nascent British nuclear programme was straightforward. Transferring Frisch to Liverpool to join James Chadwick's team there generated a significant paper trail as the requisite permissions for an enemy alien to move into a protected area (Liverpool being a strategically important port-city) were sought.[90] No such difficulties were encountered with the movements of Dominion personnel, for whom the only administrative burden, applying only to younger men, was exemption from war service.[91]

The experience of Frisch and Peierls thus highlights the barrier to inclusion faced by émigré scientists, no matter how well-integrated: their national background – their residual non-Britishness – made instinctive trust impossible. Nor was the case of Frisch and Peierls necessarily representative of the treatment of émigré

[83] Frisch, *What Little I Remember*, p.127
[84] Peierls, *Bird of Passage*, p.158
[85] Frisch, *What Little I Remember*, p.123
[86] Peierls, *Bird of Passage*, p.31
[87] Frisch, *What Little I Remember*, p.131
[88] Peierls, 22nd April 1940, AB 1/219 (TNA)
[89] Saundby to Thomson 20th June 1940, AB 1/219; Extract from Air Ministry letter 9th May 1940 (extracted 1st May 1946, KV 2/1658 (TNA)
[90] The majority of the paperwork is in AB 1/219 (TNA)
[91] Chadwick to Lockspeiser, 2nd August 1940, AB 1/219 (TNA)

scientists more widely. As Peierls had modestly pointed out, a secret they had discovered could hardly be kept from them, however much authority might ordinarily mistrust them. For those émigrés lacking equivalent exposure to the relevant information the barriers to inclusion were higher still: if not insuperable, then at least extremely forbidding. A relevant case is provided by three physicists at Bristol – Heitler, Fröhlich and London – who as Jewish refugees had left Germany c.1934-5. By 1940 they were in Bristol, and in June the question arose as to their future there: the law required that they be expelled from the city, and only the prospect of their involvement in uranium research offered the chance of a reprieve.[92] The scientists had colleagues willing to vouch for them, but their inclusion was by no means assured – indeed, it was instinctively resisted by Thomson and officials of the Ministry of Aircraft Production when the issue came to their attention.[93] Those closest to the decision-making heartland were least minded to permit their involvement, or in any way to vouch for them. Thomson partially relented a little later, conceding that they might be permitted to do relevant work provided that Chadwick directly asked for assistance, and that the work they were given should be sufficiently generic as not to give away its purpose. He stated his concern directly: 'there might be a leakage of information'.[94] The fear was not unfounded: Heitler and Fröhlich were both permitted to conduct research on the terms listed above, but the later discovery that they had inadvertently been permitted to view papers relating to MAUD prompted a flurry of strongly worded re-iterations of the project's secrecy, replete with invocations of the Official Secrets Act.[95]

It is clear, then, that an element of suspicion of émigré scientists was the default status, amongst the administrators of the project as much as in the eyes of the law. The application may have been patchy, and there was likely little malice in it, but the operating principle was undoubtedly that unless otherwise proven necessary no émigré should be entrusted with tasks or information relevant to MAUD, regardless of their *bona fides*. What is crucial to note here is that *no equivalent principle of exclusion existed for Commonwealth personnel*. Consider Mark Oliphant: privy to the crucial secrets of radar, able to access Tizard on behalf of Frisch and Peierls, and immediately co-opted onto the investigatory committee; at no point do the archives reflect any suggestion that he should have been subject to any form of screening. Other Dominion personnel were accorded comparable levels of trust and responsibility without any substantive process of security clearance or review. The same letter from Thomson that sought to distance Heitler, Fröhlich, and London from any of the sensitive aspects of the work in Bristol envisaged no issues with the involvement of J.K. Roberts, an Australian, and his assistant, Orr, ('who for a wonder is [also] a British subject'); indeed, the only challenge was to ensure that Orr should be exempted from being summoned for service elsewhere.[96]

Every nation had entered the war with access to the same baseline understanding of physics, but the war itself had curtailed the usual processes of international knowledge transfer and had redistributed the global physics fraternity. Britain was a net beneficiary of the latter.[97] Émigré scientists contributed significantly to the British programme in all its varied wartime forms. Ultimately, though, where access to nuclear secrets was concerned, two categories existed: the implicitly trusted and the instinctively excluded. Membership

[92] Cosgrave to Pye, 13th June 1940, AB 1/219 (TNA)
[93] Pye to Cosgrave, 15th June 1940; DSR minute, 15th June 1940, AB 1/219 (TNA)
[94] Thomson to Pye, 20th June 1940, AB 1/219 (TNA)
[95] Minute by J. Thewlis, 29th September 1941, and adjacent undated minutes, AB 1/220 (TNA)
[96] Thomson to Pye, 20th June 1940, AB 1/219 (TNA)
[97] So too the United States. Some fled directly to America, others came first to Britain but for various reasons moved on.

of the former category was restricted to Britons and British subjects from the Dominions, who were, indeed, treated as indistinguishable. All others – enemy aliens and allied scientists alike – were by default consigned to the latter category, and could only be drawn within the nuclear pale under exceptional circumstances. The barrier to non-Britons was certainly never absolute, and adequately vouched-for personnel from allied or neutral states (*e.g.* Halban and Kowarski from France, Egon Bretscher from Switzerland) would go on to make significant contributions to the British programme throughout the war, but it is striking to note the extent of the privilege which, by default, encompassed Dominion scientists within Britain.

First Contacts with Canada

Initial conditions for nuclear research in Britain, then, appear to reflect a paradox: the MAUD committee and its precursors were at once greatly influenced by external actors and yet profoundly restrictive of all but British and Dominion participation. This section progresses from that starting point. From a close analysis of the MAUD Committee's recorded deliberations it is possible to trace the evolution of Britain's approach to nuclear weapons development, and to identify the influence and relevance of the Commonwealth within that process. The intention here is not to repeat existing accounts of the Committee's deliberations – Gowing's account is exhaustive enough – but rather to highlight those strands of Commonwealth involvement which have tended to be overlooked or downplayed, and particularly to situate emerging attitudes towards the involvement of the Canadian government in the context of British official attitudes, especially as regarded the United States.

It was clear almost from the outset that the tasks of the MAUD Committee – assessing the technical feasibility of the bomb and envisaging the aptest pathway to its construction – could not be pursued without reference to activity outside the United Kingdom. There was the obvious need to track enemy activity, but also the countervailing need to determine the extent of, and if possible secure access to, the endeavours of allied and neutral parties. There was also the dual imperative to secure stocks of uranium *from* the enemy and *for* British use. Finally, as the necessary scale of the weapons programme became apparent, there was the question as to where facilities might be built. In addressing each of these issues, the MAUD Committee eventually looked across the Atlantic to the United States, greatest of the uncommitted powers, and, at the same time, to the British Dominion to its north.

The as-yet nameless committee to discuss the implications of the Frisch-Peierls memorandum first met at 2:30pm on 10th April 1940, at the Royal Society.[98] Its chair, by a process of bureaucratic inertia rather than any particular inspiration, was the same G.P. Thomson whose experiments had thus far succeeded only in vindicating the scepticism of external observers.[99] Joining him at this first, somewhat informal meeting were the rather more dynamic figures of John Cockcroft, Mark Oliphant and Philip Burton Moon – all alumni of the Cavendish laboratory, and all already indoctrinated into the secrets of scientific warfare. Also present, for a time, was Jacques Allier, a Frenchman bearing news of the extent of a research programme under Frédéric Joliot-Curie which had been transferred to the French *Ministère de l'Armement* in February

[98] Minutes of 1st MAUD Committee, 10th April 1940, AB 1/347 (TNA)
[99] *cf.* Tizard to Elliot, 4th May 1940, AB 1/37 (TNA)

1940.[100] Nor had Allier brought only news: he had been responsible for the safe transport to Britain of the entire available stock of Norwegian heavy water. The meeting seems not to have lasted especially long, and the minutes ran to less than a small handwritten page. The committee's default starting position was one of doubt – perhaps tinged, in several cases, with an earnest desire that weaponised fission prove impossible or impractical. Still, the precautionary principle demanded that the matter be investigated. The only resolutions were to pursue further small-scale experiments, to impress upon Frisch the importance of secrecy, and to approach Norman Haworth, a chemist at Birmingham to conduct preliminary work on separation. The latter tasks fell, naturally enough, to Oliphant. Allier's presence notwithstanding, this first meeting can hardly be said to have had a global outlook.

When the committee reconvened a fortnight later, though, international concerns were far more in evidence.[101] The same attendees, plus Chadwick, and without Allier as a guest, resolved (at last) that steps be taken to ascertain the status and safety of Belgian uranium stocks. Equally importantly, a request was sent to the biophysicist A.V. Hill, at that point engaged on liaison work in America, asking him to find out about any activity of interest in the United States. Hill's task was hopelessly broad, but the committee's initial glance across the Atlantic did presage a sustained exchange of relevant information, leading, ultimately, to the American decision to pursue nuclear weapons. Hill's first report, however, was discouraging: on 16th May, the committee learned of the American view that there was 'no possibility within practical range of using uranium either as a power source or as an explosive'.[102] (Though Hill also sent the committee a number of newspaper cuttings that seemed to suggest otherwise).[103]

In the course of the next few meetings, two other issues with international dimensions came increasingly to the fore. These were, first, the question of uranium supply, the investigations begun after the first meeting not having produced wholly reassuring results; and second, the question of where the slow neutron work of the French émigrés Halban and Kowarski, now safely domiciled at Cambridge, should be located. These two priorities would between them form the basis for Canada's incorporation into the UK nuclear programme.

Canada had first been earmarked as a known source of uranium in July 1939, as part of the United Kingdom's first, tentative enquiries into the military potential of nuclear research, but no branch of Canadian government or academia had been approached directly at that point.[104] The earliest direct communications were instigated by Cockcroft, more or less informally, and concerned the supply, not of uranium, but of heavy water. In April 1940, between the first and second MAUD meetings, Cockcroft contacted R.W. Boyle, a Newfoundland-born physicist now serving as a senior figure in the Canadian National Research Council (NRC), enquiring whether heavy water could be obtained in Canada, and if so, in what quantities.[105] The perturbing response was that stocks were unexpectedly low.[106] These inquiries

[100]Handwritten notes in AB 1/210 (TNA)
[101] Minutes of 2nd MAUD Committee, 24th April 1940, AB 1/347 (TNA)
[102] Hill, 'Uranium-235', 16th May 1940, AB 1/219 (TNA)
[103] *e.g.* Hill, 6th May 1940, AB 1/650 (TNA)
[104] Pye to Elliot, 6th July 1939, AB 1/37 (TNA)
[105] Cockcroft to Boyle, 20th April 1940, AB 1/210 (TNA)
[106] Cockcroft to Boyle, 28th May 1940, AB 1/210 (TNA)

seem, to have been made at least partially at the behest of the French: Allier wrote to Cockcroft in May 1940, on the subject of heavy water, invoking an earlier promise by Cockcroft to make enquiries on the topic in the United States and Canada.[107] At any rate, the French were being kept closely informed of the Canadian heavy water position: when Boyle telegrammed Cockcroft regarding Canadian supplies on 16th May 1940, Cockcroft soon after told Allier the outcome.[108] It is important to note, too, that Boyle's enquiries on Cockcroft's behalf were not solely domestic: he also reached out to American suppliers in an effort to ascertain their capabilities, faithfully passing on their responses.[109] These extraterritorial enquiries were made in the name of the NRC only; no connection with the UK was avowed.[110] It is unclear how representative Boyle's attitude of ready co-operation was of the NRC as a whole, but his (semi-official) correspondence with Cockcroft certainly reflects personal warmth and solidarity.[111]

The Cockcroft-Boyle route was not the only form of Anglo-Canadian nuclear contact established during the summer of 1940. Other enquiries were transmitted through different channels (and do not appear to have been shared with the French). Questions were asked directly of the NRC about available uranium stocks and the potential ability of the Canadians to produce uranium metal.[112] This set of enquiries, transmitted through departmental channels, met with a prompt response: the Canadian physicist G.C. Laurence was enlisted to make enquiries. At around the same time, James Chadwick learnt from the chemist Otto Maass of the Canadians' success in producing uranium metal; Maass even pledged to secure some for him. That this was an unofficial contact is evident in Chadwick's reaction: his interest piqued, he now cast around to discover 'the proper method of approach'.[113] Nothing in the correspondence, official or otherwise, suggests that the NRC yet had any sense – at an *institutional* level at least – of the reason for British interest in the material; only a handful of more or less fanciful applications are referenced as possible explanations for earlier German interest in Canadian supplies.[114] The Canadians were, however, able to report (via their Department of External Affairs: evidence that these enquiries, at least, were passing through the 'proper' channels) that they had been working on various production methods and alloys of uranium.[115] This in itself was significant news to the British.

Was there, then, an endogenous Canadian scheme? Cockcroft, who crossed the Atlantic as part of the famous 'Tizard Mission' to share some of the fruits of British technological prowess to the United States, had also various errands in Ottawa, which included the making of enquiries as to the precise status of Canada's capabilities.[116] The British emphasis at this time on establishing the 'position of the work in that country' certainly implies a genuine ignorance,[117] and the phrasing of Cockcroft's report on his discussions

[107] '*Vous avez bien voulu, lors de mon passage à LONDRES le 10 avril, me promettre de faire un enquête tant au CANADA qu'aux ETATS-UNIS…*' Allier to Cockcroft, 9th May 1940, AB 1/210 (TNA)
[108] Boyle to Cockcroft, 16th May 1940; Cockcroft to Allier, 18th May 1940, AB 1/210 (TNA)
[109] Ohio Chemical and MFG Co. to Boyle/NRC, 13th May 1940, AB 1/210; Boyle to Cockcroft, 9th July 1940, AB 1/346 (TNA)
[110] Boyle to Cockcroft, 9th July 1940, AB 1/346 (TNA)
[111] One of his messages to Cockcroft concludes in familiar terms: 'I trust that you are all standing up well under these stressful times and keeping in the best of form and spirits. As a matter of fact I wish I was over there with you'. Boyle to Cockcroft, 26th June 1940 AB 1/346 (TNA)
[112] *e.g.* Gough to Mackenzie, 20th June 1940, AB 1/346 (TNA)
[113] Chadwick to Cockroft, 11th June 1940, AB 1/210 (TNA)
[114] Mackenzie to Skelton, 20th June 1940, AB 1/346 (TNA)
[115] Stedman (NRC) to Wright (DSR Admiralty), 19th June 1940, AB 1/346 (TNA)
[116] Mackenzie to Gough, 4th August 1940, AB 1/219 (TNA)
[117] Dickins to Lovell, 12th November 1940, AB 1/219 (TNA)

at Ottawa makes clear that at least some of the ongoing Canadian work was not conducted under UK oversight:

> I have attended a meeting of the N.R.C. and have learned all the work proceeding in this country. In general it is proceeding on rather parallel lines to ours, with no outstanding developments of greater promise than our own work. They had done a fair amount of work on the preparation of uranium hexafluoride…[118]

One might thus justifiably speak of Canadian nuclear research as initially independent, in that nuclear research had taken place of the Canadians' own volition, not at the behest of the UK. This is not to imply that the Canadian work was a nascent weapons programme, though: Laurence's work was tangentially relevant, inspired by the pre-war acceleration of nuclear physics work, but until contacts developed with the MAUD Committee his research was small-scale and far from programmatic. The prompt from MAUD led, however, to an immediate reconfiguration, aligning it more directly with British interests. Laurence and his team subsequently made good use of the technical details (and occasional steers) they received from Britain, with the result that several papers – on specific technical issues and on the general state of North American nuclear research – were fed back profitably to London.[119] The value the British set by this (admittedly small-scale) work is apparent in the later willingness of MAUD Committee members to seek methods by which it could be sustained.[120] Even at this early stage it is therefore clear the MAUD Committee's contacts with Canada were no mere transfer of knowledge from one side of the Atlantic to the other: it was, from the outset, a reciprocal interaction.

There remains also the question of how much the Canadians were told, when, and how explicitly. As the MAUD report would eventually make clear, the lines on which the committee was working were considered to be such 'as would be likely to suggest themselves to any capable physicist'.[121] Canada certainly possessed a handful of such physicists, some of whom – Laurence and Maass – have already been referenced. The flurry of urgent queries from London relating to the securing of uranium stocks was at the very least highly suggestive. Members of the NRC certainly inferred enough from the international situation, and from British comments, to have recommended, as early as June 1940, a prohibition on the export of uranium from Canada.[122] By the end of July it was reasonably evident to the Canadian government that the United Kingdom, for whatever reason, had developed an interest in uranium metal; the number of requests passing to the NRC through the High Commission proved as much.[123] From August onwards it is evident that the NRC as an institution was beginning to develop a clearer sense of the specific nature of the British interest, for in answer to a question on the uses of uranium hexafluoride the formal response fixated on isotope separation, there being few other purposes to which the compound might, in their view, be usefully put.[124] The arrival of the British physicists Ralph Fowler in Ottawa to conduct general scientific

[118] Extract Cockcroft to Gough, 11th October 1941, AB 1/219 (TNA)
[119] *cf*. Cockcroft to Fowler, 18th Feb 1941, AB 1/346; Fowler to Cockcroft, 24th Feb, AB 1/233 (TNA)
[120] Cockcroft to Fowler, 8th January 1941, AB 1/346 (TNA)
[121] MAUD Committee Report, July 1941, AB 1/347 (TNA)
[122] Snelling to Skelton, 20th June 1940, AB 1/346 (TNA)
[123] Snelling to Gough, 27th July 1940, AB 1/346 or AB 1/210 (TNA)
[124] Mackenzie to Gough, 4th August 1940, AB 1/219 (TNA)

liaison would also have allowed face-to-face discussion for the first time, and it may be that a restricted few within the NRC had therefore been briefed fully on 'the uranium position' by early August.[125] Those familiarised with MAUD's activities would have included Boyle, as the initial contact, and C.J. Mackenzie, the Acting President of the NRC, who had become the conduit for the formal contacts between DSR and the NRC. The other most likely inductee is Laurence, who in addition to having already shared details of his own work, had taken a leading role in the NRC's enquiries in the United States. In December 1940 he produced a remarkably thorough set of notes on 'Nuclear Fission Research in the United States', which covered the topics of isotope separation, uranium hexafluoride, metallic uranium, chain reaction physics, and uranium stocks.[126] The specificity of his enquiries, and his grasp of the technicalities in each area, imply that he had been well-briefed on UK interests; if not, these were remarkably accurate educated guesses. It is not therefore stretching the evidence too far to suggest that by late summer 1940 the NRC could realistically have claimed to have learnt the basic scope and direction of MAUD's investigations. It may remain an open question as to when Canada was *formally* inducted into the nuclear secret, since Fowler's writ may not have extended further than the giving of personal briefings to chosen confidantes, but it matters little in comparison with the key point, which is that the *informal* induction of Canadians into the UK's emerging nuclear research programme took place, piecemeal, through the summer of 1940.

The Canadians thus became recipients of significant volumes of information, comparable to (and likely in excess of) the volumes passing to the United States at this time. Relevant papers were sent from Britain to Canada, partly to support the research being undertaken there, but also as a form of insurance policy. This was, after all, a vulnerable period in the war for Britain. In September 1940 there were discussions as to whether some of Peierls' MAUD papers on isotope separation should be forwarded to Cockcroft, who was visiting Canada, in order that they might be 'deposited with the N.R.C. for safe keeping'.[127] In the event, the papers were sent directly to Mackenzie: the covering note for the first batch (on separation) made clear that the papers were to be used by the NRC ('The papers will…certainly be of interest to those of your staff who are connected with this problem') but that Canadian custody of the information they contained also represented a precautionary measure ('In any case I would like to ask you if you would be good enough to preserve these papers in safe keeping for us against unforeseen contingencies').[128] Other papers sent included portions of Halban's slow neutron work. In all, Canada received information almost equivalent to the basis of a full nuclear development programme.

Little has been said here about Britain's corresponding contacts with the United States in the same period, not simply because these contacts have received adequate attention elsewhere, but also to redress the balance. Instead, it is important to recognise that British nuclear interactions with Canada began early, and were *not* simply a later adjunct to contacts with the United States. This emphasis on early Anglo-Canadian interactions is, however, somewhat contrary to the implication even of many Canadian histories. Brian Buckley's *Canada's Early Nuclear Policy*, one of the best Canadian accounts, does briefly acknowledge that Canada was 'not without assets in the field', and recognises Laurence's independent work, but his

[125] Cockcroft to Boyle, 30th July 1940, AB 1/346 (TNA)
[126] 'Nuclear Fission Research in the United States', 6th December 1940, AB 1/171 (TNA)
[127] Dickins to Webster, 29th September 1940, AB 1/346 (TNA)
[128] Gough to Mackenzie, 1st October 1940, AB 1/346 (TNA)

assessment is nevertheless that Canada's wartime endeavours in nuclear physics 'arose largely from the complexities of the Anglo-American nuclear relationship, rather than any strategic initiative by Canadian scientists or policymakers'.[129] In and of itself, this statement is accurate enough, as the subsequent chapters will attest, but it carries with it the unfortunate implication that Canada was wholly marginal to British decision-making until far later into the war, and that the Canadian role was far more passive than was actually the case. Canadian personnel and resources were not simply subordinated to British requirements: this was, from the outset, an interaction between active parties. British interest in Canada was bolstered by Canada's own interest in the field. Had Laurence or Maass been occupied with other interests, and had Boyle and his colleagues been less amenable to Cockcroft's queries, the initial contacts between the two countries would have been fewer and more cursory, and the later appeal of Canada as a location for nuclear work – still less as a partner in that work – would have been correspondingly less. What Buckley glosses over, and other accounts have missed altogether, is that the MAUD Committee's first glance across the Atlantic took in both Canada and the United States, and that the Canadian connection was no mere after-thought, but rather the forerunner of the more complex ties that would later emerge between the three parties.

Looking Across the Atlantic

Fostering a dynamic of exchange is one thing; the commencement of a joint programme is another. The idea that the UK might base some or perhaps almost all of its nuclear work overseas, whether in Canada or otherwise, was not initially in view. Only with historical hindsight does the impression emerge that the British immediately sought to place their research outside the UK (rather than simply to engage in dialogue with external partners). The idea of crossing the Atlantic in fact emerged fitfully, and was prompted in part by wartime exigencies: Britain was, after all, within range of German bombers throughout this period, and any programme in the British Isles, however covert, would have been acutely vulnerable. Two other factors contributed, however: the ongoing development of contacts with both Canada and the United States, providing a significant lure, and the need to find an appropriate home for the French émigré scientists acting as a push-factor. Both of these factors have been underdeveloped in existing scholarship, and are therefore explored in depth here.

Hans von Halban and Lew Kowarski, two scientists from Joliot-Curie's laboratory, had been among the many Frenchmen who had managed to flee the fall of France and take refuge in England. They had brought with them a significant quantity of heavy water and an enviable knowledge of slow neutron reactions. They could undoubtedly be of great value to the British programme, if only they could be satisfactorily incorporated into its still rather *ad hoc* structure. The two scientists wished to continue their research – indeed, felt honour-bound to do so – but were not necessarily content to remain in the United Kingdom, where resources and safety were equally scarce. The nature of their integration into, or perhaps more accurately, the terms of their *co-operation with* the nascent British nuclear programme, became another vexed issue for MAUD to address.

[129] Buckley, *Canada's Early Nuclear Policy*, p.21-22

The matter was considered at length in the MAUD Committee, though too slavish an adherence only to the formal record might give a false impression. In the minutes of the fourth MAUD committee meeting, held on 10th July, the Halban-Kowarski issue received little attention, the upshot of the apparently brief discussion being simply that the committee would prefer them to stay in the UK, but that since Halban had professed himself unwilling to do so, the idea of their working in 'America' (a potentially ambiguous word) would be explored. Canada is scarcely mentioned, save in two resolutions: that Thomson should instruct Fowler, before the latter left for Canada, to 'make informal overtures with regard to Canadian and American co-operation', and second, that Cockcroft should make further enquiries about the prospects for obtaining heavy water from Canada.[130] The former resolution tentatively envisaged tripartite co-operation, the latter addressed only an issue of supply, but both at least foresaw a role for Canada in what was still very much intended as a British-dominated endeavour. Yet the participants' correspondence immediately after the meeting gives a different (and far more confusing) impression. Oliphant's understanding on 11th July was that a transfer to the United States was proposed.[131] Cockcroft, on the 12th, accepted the premise that Halban should work 'in America' in one letter, whilst questioning it in another ('I think the question… should depend upon the conclusion of a general understanding with the U.S.A'; 'I think that it is best to work on the assumption that he will work in… Ottawa').[132] In a further letter on the same day, to Fowler, to whom the task of Canadian liaison had seemingly now fallen, Cockcroft managed to give the impression that the committee favoured sending Halban and Kowarski to Canada to work under the NRC, with no reference to the United States.[133] A few days later, both Cockcroft and Chadwick seemed to have settled on the assumption that Canada was the preferred option, which Chadwick personally opposed: 'I think the decision to allow them to work in Canada is really wrong although it may perhaps turn out well enough'.[134] The reason for all this confusion is unclear: Cockcroft's early departure in the final stages of the committee's discussion cannot have helped, but even this does not explain Chadwick's similar vacillation between the two possibilities, or the stark discrepancy between the content of minutes and the evidence of the correspondence.

More perplexing still is Halban's own account of the meeting, as recorded in a typed diary for 1940 now held in the National Archives. In the diary, Halban describes several meetings with MAUD Committee members in the run-up to the meeting. He was particularly scathing about G.P. Thomson ('remarkable ignorance.... The whole level of the conversation was extremely low'), but was far more complimentary about Chadwick, whom he records as having pointed out 'that it might be wise to shift the whole work to Canada where conditions might be more favourable for long term research'.[135] This statement is difficult to reconcile with the opposition Chadwick expressed to the idea a fortnight later, unless either Chadwick's mind had been changed in that time, or Halban's account is faulty. Halban's account of the fourth meeting itself is no more helpful: in it, Halban records his remarks to Thomson (who is again criticised, this time as 'unco-operative' and 'unpolite'):

[130] Minutes of 4th MAUD Committee Meeting, 10th July 1940, AB 1/347 (TNA)
[131] Oliphant to Cockcroft, 11th July 1940, AB 1/210 (TNA)
[132] Cockcroft to Chadwick, 12th July 1940; Cockcroft to Oliphant, 12th July 1940, AB 1/210 (TNA)
[133] Cockcroft to Fowler, 12th July 1940, AB 1/210 (TNA)
[134] Cockcroft to Chadwick, 15th July 1940; Chadwick to Cockcroft, 18th July 1940, AB 1/210 (TNA)
[135] Halban diary, *circa* 3rd July 1940, AB 1/569 (TNA)

> I informed him that our intention was to help the British War effort and that it was our greatest desire that any progress in the chain reaction field should be obtained in England, that in proposing Canada we thought to go there as a British team reinforced by British scientists...[136]

This implies that the idea of working in Canada had originated with Halban and Kowarski themselves, or at least that they had been the ones to raise it with the committee. (If the former, Chadwick's apparent support a week previously may perhaps be explained as a result of his having reflected back to Halban, it may be over-politely, Halban's own idea). Halban then describes a scene in which he and Kowarski, having left the meeting, were waylaid by Thomson, who told them that the consensus was now that the US would be better than Canada. This conversation, continued in a taxi, concluded with Thomson telling them not to hold out too much hope about Canada, but reassuring them that Fowler would at least make enquiries in Ottawa. Finally, Halban cites a meeting with Cockcroft two days later in which Cockcroft was again described as having understood that Canada was the preferred option.[137]

These are remarkable and suggestive claims. The Halban diary is, however, a problematic source for this period, for two reasons. First, despite superficial appearances, it cannot be contemporaneous: Halban at points reflects on the long-term significance of some of the incidents he describes, meaning that the text was, at the very least, substantively edited at a later (conceivably post-war) date. Second, the dates he provides are demonstrably inaccurate. His diary places the fourth MAUD committee meeting – the context for a significant discussion, which he recounts at length – on *Wednesday 7th July 1940*. No such date occurred in 1940: 7th July fell on a Sunday. The official minutes of the meeting correctly place the meeting on Wednesday the 10th.[138] As a source, the diary is therefore vulnerable to the charges of inaccuracy, non-contemporaneity and – most damning – of advancing some particular agenda (of which disparaging G.P. Thomson appears to be a part).

Allowing for all of these caveats, and placing little analytical weight on the specific claims of the Halban diary, a number of points can nevertheless be taken as settled. First: Canada seems to have been discussed seriously as an option for hosting aspects of the British programme, distinct from and perhaps ahead of the United States, at the MAUD meeting on 10th July. Second: regardless of the idea's precise origin, Halban and several of the committee appear to have been amenable to the transfer of the work to the NRC. Third: others, including, it seems evident, the chairman, were more seriously opposed to any Canadian venture, with some strongly preferring the United States. Fourth: the minutes in the National Archive are not, for whatever reason, a comprehensive reflection of all that was discussed.

Fowler, having faithfully discharged his investigatory mission in Ottawa, gave his assessment of the prospects for placing a British nuclear team in Canada. He concluded that Canada was 'the ideal place for the work', but that it was perhaps rather a 'stiffish proposition' to expect them to take Halban and Kowarski, who were largely unknown on that side of the Atlantic.'[139] The Halban-Kowarski conundrum was not the

[136] Halban diary, 7th [10th] July 1940, AB 1/569 (TNA)
[137] Halban diary, 9th [12th] July 1940, AB 1/569 (TNA)
[138] One possibility is that Halban (or his transcriber), writing at a later date, made the elementary error of checking his notes against the contemporary calendar rather than referencing back to the correct year. 7th July occurred on a Wednesday in 1943 and 1948.
[139] Wooldridge to Cockcroft, quoting Fowler, 27th August 1940, AB 1/210 (TNA)

only item of MAUD business with a transatlantic component, however. It would be well to recall that Halban and Kowarski's work was on slow neutrons, and was therefore considered a distinct sub-category of fission research, by no means the most promising from a military perspective. Fast neutron research, as conducted by Chadwick, seemed more urgent – a point Oliphant had made to Cockcroft:

> Under the circumstances I agree with the general conclusion that Halban and Kowarski should work in America…. I am afraid that I still feel that if this work is important enough to go to America, the work which Chadwick has undertaken is still more eligible for that move.[140]

It was, moreover, becoming clear that large-scale uranium enrichment work would also be required, and could not easily be undertaken by Britain's hard-pressed war industry. Fowler, aware of all this, pointed out that the Canadians would welcome British fast neutron researchers like Chadwick 'with open arms'.[141] It is clear, then, that when the British first began to envisage any of their work crossing the Atlantic, Canada was seen as the likelier and to some extent preferable candidate. The mantle of leadership in nuclear research had not yet passed to the United States, and though interaction with the Americans was to be welcomed, the instinct was nevertheless still to work, where possible, with the Canadians. More fundamentally, a clear sense was emerging that however desirable a wholly British-located scheme would be, at least some of the work must be conducted in North America.

The Significance of Mark Oliphant

As his frequent appearances in preceding pages demonstrate, Mark Oliphant was a figure of some significance in the early stages of the UK nuclear programme. This section seeks to outline the extent of his early influence, and to highlight his position as the first and most privileged of the many Dominion scientists to have engaged with sensitive aspects of the British nuclear programme. This shift from the general to the particular – from the abstract interactions of committees and government departments to the role of a single individual – is not intended to represent a departure from the theme of the chapter thus far, but rather to reinforce it. The contention of this thesis is that from first to last, Commonwealth dynamics played a significant role in shaping the development of the UK nuclear programme. This is as true at the individual level as at the structural. If anything, these dynamics were more pronounced in the lives of individuals, since they emerged from lived experience rather than the more nebulous phenomenon of institutional consensus. Paying close attention to Oliphant's role, then, serves to highlight a unique commonwealth experience and, in so doing, to cast light on the mechanisms by which Dominions could later engage with the British nuclear programme.

The first thing to note about Oliphant is the extent of his integration into the formal and informal networks that would later underpin the British nuclear programme. Although born and educated (to undergraduate level) in Australia, Oliphant had been in Britain since 1927. A decade at the Cavendish, the imprimatur of

[140] Oliphant to Cockcroft, 11th July 1940, AB 1/210 (TNA)
[141] Wooldridge to Cockcroft, quoting Fowler, 27th August 1940, AB 1/210 (TNA)

Rutherford's approval, and an eventual appointment as Poynting Professor of Physics at Birmingham all served to place Oliphant firmly within the ranks of the British physics establishment. He was therefore doubly trusted, as a British subject (there was no legal disaggregation of UK-born Britons from Australians-in-Britain at this point) and as a vouched-for colleague. His early initiation into the secrets of British radar – which had come, via Cockcroft, in the autumn of 1938 – reflected as much.[142] Oliphant's ostensibly unsought position as champion of Frisch and Peierls' memorandum (the first and most foundational of his contributions to nuclear weapons history) was not, therefore, out of place: rather, it was entirely unremarkable that a well-regarded Australian physicist, long domiciled in Britain, should be able to access the upper echelons of British defence science, and equally unsurprising that he should have been be co-opted into relevant work on behalf of the British government.

Oliphant's patronage of the Frisch-Peierls memorandum was certainly crucial to its uptake: without his active support and engagement, its conclusions might well have gone unheeded, or unread. It matters, therefore, that Oliphant understood, endorsed, and acted swiftly upon the conclusions with which he was presented in the spring of 1940. This thesis certainly cannot aspire to the level of omniscience claimed by Oliphant's biographers, who depicted their subject ensconced in 'the quiet of his office', reading the memorandum 'with a mixture of excitement and consternation',[143] but Oliphant's own covering letter to Tizard, in which he strongly commended the work, can at least be taken as evidence of his willingness to advocate personally for further exploration.[144] Oliphant's words carried weight: they prompted the formation of the MAUD Committee, from which, ultimately, emerged the British wartime nuclear programme. Oliphant's, then, was a significant role: he had been the crucial conduit to government, and thus a key participant, along with Frisch and Peierls, in the catalysing process.

Yet it would be wrong to cast Oliphant only as the right man in the right place at the right time, as though his role in the story were simply to recognise good work and dutifully pass it on. In the spring of 1940 Oliphant was *already* working on uranium problems – and not from mere intellectual curiosity, as per Laurence in Canada, but in conjunction with government defence science. That Oliphant had engaged in nuclear physics work is of course no great revelation, his entire scientific career to that point having been in that area, but the closeness of his engagement with government, and the clear military implications of his non-radar work c.1939, are somewhat striking. Witness an administrative letter from Henry Tizard (he of the Committee for the Scientific Survey of Air Defence, amongst other government roles) dating from May 1939, referencing an offer of official help for Oliphant's 'preliminary' work on the uranium problem; Oliphant, in responding, requested a few pounds of 'reasonably pure' U3O8, from which he would work on the manufacture of uranium metal.[145] Even more compelling is the letter he wrote on 30th May 1939 – before Frisch had even arrived in the UK – to the American physicist Ernest Lawrence:

> We are very interested at this time in the problem of nuclear fission and in the possibility that it may at some time prove to be a source of power or of explosion. I am quite sure these

[142] Stewart Cockburn and David Ellyard, *Oliphant: The Life and Times of Sir Mark Oliphant* (Adelaide: Axiom Books, 1981), p.81
[143] Cockburn and Ellyard, *Oliphant,* p.100
[144] Clark, *Tizard*, p.218
[145] Tizard to Pye, 31st May 1939, AB 1/219 (TNA)

> possibilities are very remote, but the Defence authorities here feel that there must be absolute certainty that no possibility is overlooked in this direction, as there are rumours that great developments have taken place recently along this line in Germany[146]

This alone is evidence enough to identify Oliphant as one of the very few active, well-informed participants in the (admittedly still small-scale and speculative) uranium work referenced in previous sections. On 24th August 1939 Oliphant again wrote to Lawrence, reporting in significant detail on his progress: he explained that he was interested in fission, that he reckoned isotope separation would be required, and that he was therefore looking into thermal diffusion processes.[147]

All of this casts new light on Oliphant's role in the uptake of the Frisch-Peierls memorandum, transforming him from an essentially passive actor, responding to the work of others, into a potentially far more dynamic initiator of action. Indeed, it leaves open the possibility that Frisch and Peierls' 'hypothetical' discussions about uranium fission may have been rather more directed than their later accounts seem to imply. Oliphant's biographers Cockburn and Ellyard seem little interested in evaluating their subject's actual engagement with the uranium question in this period, but even they note how greatly Oliphant stood to benefit from Frisch joining Birmingham, if only as an impressive addition to his fledgling physics department.[148] How much more beneficial, though, to have brought the leading expert on uranium fission to one of the very few places in the country where the possibility of weaponising uranium fission was under active consideration!

Oliphant was one of the most prominent early members of the MAUD committee. As outlined above, the bulk of the actions taken after the first meeting – actions relating to recruitment and security – fell to him. His interventions in subsequent meetings were perhaps fewer in number than others of equivalent rank – he was, after all, less directly involved in the practical work – but were nevertheless salient and seem to have carried significant weight in shaping the conclusions of the committee. His was a positive voice, noticeably more open than others of his colleagues to the idea of co-operation with the Canadians and/or Americans. Note, for example, the prescient call to action in his contribution to the third technical meeting of the MAUD committee:

> Professor Oliphant considered that the time had come to take a decision regarding the future of the work…. He considered that the work could not be profitably done in this country for this war and suggested that it would be desirable to send Dr. Halban and his team to Canada and make the work a co-operative effort between the United States and Canada.[149]

Oliphant's official standing within MAUD declined as the work of the Committee itself gained momentum, and after the distinction was made between the policy and technical functions of the committee (from 17th September onwards) he would attend only those sessions relating to the latter.[150] This was a relegation of

[146] Cockburn and Ellyard, *Oliphant,* p.98
[147] Ibid., p.98
[148] Ibid., pp.98-99
[149] Minutes of Third MAUD Technical Committee, 9th April 1941, AB 1 /347 (TNA)
[150] Ibid.

sorts, but not ultimately a substantive one: Oliphant had other pressing priorities, including his longer-established work on radar, and the streamlining of the policy committee did not prevent Oliphant continuing as an advisor and confidant to those more closely concerned with the Committee's research. This, in fact, was Oliphant's main form of influence during this period, more so than through MAUD meetings themselves. The papers of the MAUD Committee reveal a core membership, composed of Thomson, Chadwick, Cockcroft, and Oliphant, to whom almost all papers were habitually circulated.[151] This extended well beyond the formal circulation of minutes: almost all new developments, whether regarding technical matters or intelligence on the German programme, were discussed between these four men, with Oliphant often the most engaged.

Oliphant, then, was both influential and atypical. He had shepherded the British programme into existence, and had helped catalyse the American work. The picture that emerges is of an activist physicist, not content simply to be consulted, but willing rather to agitate, on both sides of the Atlantic, for actions he thought necessary. This was a man temperamentally and situationally suited to the playing of a central role. None of this is meant to imply that these factors in Oliphant's influence owed, somehow, to his Australian heritage. Nationality is seldom the main determinant of one's character, and portraying individuals as representatives of some national archetype, common though it may be, is either poor scholarship or lazy writing. At this stage, it mattered little that Oliphant was from Australia: he differed from his colleagues in no sense, save in his proactivity. Later, though, his heritage would come to matter a great deal.

Conclusion: MAUD and the Commonwealth

A chapter concerned with initial conditions must strike a delicate balance between nescience and prescience as regards what must follow. On the one hand, origins matter: it is reasonable to suggest that in the earliest stage of any great endeavour might lie the germ of its eventual course. Yet contingency matters too, and subsequent events can overshadow or drastically redirect early trends. This is certainly the case in nuclear history, where the later prominence of the United States casts a long historiographical shadow, and where the nuances of Britain's early, tentative engagement with nuclear weapons research can therefore be lost in an effort to detect the causes of America's eventual supremacy. For this reason, this chapter has placed significant emphasis on granular details, eschewing wherever possible the sorts of monocausal explanations that so often underpin linear narratives. The origins and transitions with which this chapter has been concerned are instead taken to prefigure key themes which would emerge, to varying degrees, in the later history of the British nuclear programme, but without attaching any connotation of inevitability. Insofar as the themes that are emphasised in this chapter – the tentativeness of the British approach, the varied national origins of key contributors, the privileged position of Dominion personnel within British defence science, the particular significance of Mark Oliphant, and the early association of Canadian personnel and institutions with British nuclear research – point to corresponding themes emerging in later chapters, they do so indicatively but not deterministically.

[151] Minutes of Third MAUD Technical Committee, 9th April 1941, AB 1 /347 (TNA)

There was certainly no 'eureka' moment to sate the human impulse for narrative excitement, though Frisch and Peierls' memorandum admittedly came close. Rather, initial scepticism gave way to belief only gradually, as calculation and experiment demonstrated the feasibility of each stage along the pathway to the bomb. This gradual accretion of evidence was mirrored by the gradual articulation of policy, where similar reversals and dead-ends were encountered, and a similar spirit of uncertainty prevailed. It is frustrating for a historian to admit that his subjects seem genuinely to have been unable to decide unequivocally between the various options; but these evident uncertainties reiterate contingency. Such caveats are important. Revisiting the preliminary investigations makes clear the extent to which the context of war ensured that Britain's nuclear policy was not developed *tabula rasa* but rather took on complexly multi-national emphases from the outset. The processes by which the MAUD Committee came into existence, and acted, reflected providence working through iterative deliberations, rather than the inexorable playing-out of linear processes. This acknowledged, several things become clear.

First, and foundationally, it is clear that the treatment of actors in relevant fields (in terms of access granted and suspicion accorded) depended primarily on their national backgrounds, with British subjects – a category which reflexively included those from the Dominions – automatically privileged over all others. This in turn meant that at least one figure from the Dominions, Mark Oliphant, could play a central role in shaping the development of the nascent programme, whilst even hugely influential figures from outside the Commonwealth were pushed to the fringes or excluded altogether (albeit only temporarily in some cases).

Second, it is clear that contacts with Canada developed at a very early stage. Liaison over material supply began almost immediately upon the formation of the MAUD committee, and the exchanges that developed, although conditioned to some extent by assumptions (on both sides of the Atlantic) of British primacy, were reciprocal in several key respects. The warmth of Anglo-Canadian institutional and personal ties (buoyed, in part, by the common thread of past connections with Rutherford) and the existence within Canada of relevant research, small-scale and unsystematic though it was, enabled immediate – one might reasonably say *instinctive* – collaborations to develop. These, in turn, helped foster a sense among British decision-makers that Canada, with all of its geographical advantages, might seriously be considered as a potential domicile for both the slow and fast neutron work. Nor only as a domicile: by the time the MAUD Committee began to reach its first conclusions it was clear that the Canadians were willing, indeed keen, to engage with Britain on whatever programme the United Kingdom might eventually develop.

Third, it is clear that amidst the opacity of MAUD's deliberations around transferring some or all of the programme outside the UK, Canada was conceived of as a possible location in its own right – which at a basic level alters slightly the existing literature's perception of Canada as simply a fall-back option. That Canada was later eclipsed by the US as the probable/preferred locus for British work in North America was a consequence of eventual practicality and the ebb and flow of alliance politics, not of initial preference: Canada was clearly seen by many (but by no means all) MAUD contributors as no less reasonable an option than the United States, for the advantages of kinship and the prospect of close, easy co-operation helped outweigh the industrial advantages to be found south of the border.

Above all, though, it is clear simply that the unique circumstances pertaining to Britain's first foray into nuclear research had as their most foundational consequence the extension of British nuclear horizons beyond the British Isles, and particularly to Canada and the United States. Canada, in particular, attained an early engagement with nuclear affairs that has not been adequately reflected in previous scholarship. If nothing else, it is striking to note that long before the Americans had committed to the nuclear enterprise, whilst Britain still held the initiative, Canada had been inducted into the nuclear secret. It was in this earliest period, when the contours of the British nuclear programme had yet to be determined, that exchanges of data within and around the British-American-Canadian 'triangle' began.[152] These soon became habitual and did not fully cease even when transatlantic relations hit their lowest ebb. Relationships had formed, pathways for information exchange had been created, and a combination of geography, affinity and providence had inclined both parties to expect further close collaboration. As the next chapter will discuss, the subsequent inexorable shifting of the nuclear centre of gravity from one side of the Atlantic to the other led ultimately to the fulfilment of this expectation – albeit in forms which neither the British nor the Canadians could yet have predicted with any accuracy, via processes which belied the expectation of comfortable intra-commonwealth solidarity.

[152] Webster to DSR, 7th July 1941, AB 1/650 (TNA) details some of the first exchanges.

Chapter Two:
The Centre of Gravity Shifts

This chapter addresses the liminal period in which the British nuclear weapons programme began in earnest, and in which, for the first time, elements of the programme itself were transplanted outside the United Kingdom. The chapter is therefore concerned with two sets of transitions: first, the transition from theory to practice – that is, from the solely academic preoccupations of MAUD to the industrial-scale ambitions of Tube Alloys; and second, the transition of the nuclear centre of gravity from one side of the Atlantic to the other, as the American programme supplanted the British in scale and advancement. These two transitions cannot easily be disaggregated for the purposes of historical explication, for each influenced the other, iteratively and contingently. The cumulative effect of these interlinked processes was a complete re-ordering of the conditions described in the previous chapter. In the summer of 1940, as the MAUD committee began to find its administrative feet, the United Kingdom had clearly possessed the most advanced, best-motivated nuclear research programme. The pursuit of comparable work by the United States was a matter of natural interest and friendly exchange but otherwise held little sway over British policy-makers; the small-scale work conducted by the Canadians was the recipient of semi-official British support but had not yet been formally co-ordinated with the British programme. By the end of 1941, though, the United States had become the undoubted nucleus of atomic weapons development; the fates of the British and American programmes had, in the eyes of British policy-makers, become almost inseparably enmeshed; and a joint Anglo-Canadian Laboratory had been established at Montreal to pursue an increasingly important line of enquiry. This last development might easily be overlooked or downplayed in contrast with the two preceding, and indeed it has been a trend in British nuclear history to treat the establishment of the Montreal Laboratory and the entirety of Canada's engagement with wartime nuclear research as a mere side-show to the more important dynamic of British dependence on the United States – supposedly the cardinal feature of all subsequent British nuclear history.[1] This thesis contends otherwise. The argument here is that this period of transition cannot be fully comprehended without adequate attention to Canada, for without such attention a crucial element in both British and American nuclear histories is lost. The process by which Canada came to be favoured for the relocation of British heavy water work even after the United States had become Britain's more influential nuclear partner requires explanation, as does the fact that no corresponding transfer of fast neutron research to Canada ever took place. The question underpinning the chapter can therefore be framed as follows: *how was it that part, but only part, of the UK nuclear programme came to be transplanted to Canada?*

Approaching this question with a sensitivity to the Commonwealth dynamics of British policy-making makes it possible to revisit and question several tropes of nuclear history. These tropes, inherited partly from the archival record, partly from Gowing's pathbreaking early analysis, and partly from the simple agglomeration of historians' assumptions, whether well- or ill-founded, include the suggestion that the creation of the Montreal Laboratory was a simple act of imperial imposition on the part of the British (or

[1] *cf.* Margaret Gowing, 'Britain, America and the Bomb', in Dockrill, Michael and Young, John W. (Eds.), *British Foreign Policy 1945-1956* (London: Macmillan, 1989), p.31

at best acquiescence on the part of the Canadians) and the criticism, present in Gowing and implicit in much subsequent scholarship, of British handling of American overtures regarding collaboration in late 1941 and early 1942 (the suggestion being that British dilatoriness and arrogance resulted in a opportunity missed). Each of these tropes requires some emendation in light of the archival record.

The chapter surveys four key themes, introduced chronologically. The MAUD report itself is addressed first, since the process of its receipt and implementation set the initial trajectory of British nuclear work. This segues naturally into a consideration of the increasing significance of the United States, for it is argued that the MAUD report played a crucial role in catalysing the American programme as well as the British. Attention is consequently paid to the impact of that catalysis on British policy – including on the nascent collaboration with Canada described in Chapter One. A significant consequence of the United States' sudden centrality to British policy was the reification of the idea that some or all of the British work might be conducted on the other side of the Atlantic. An analytical narrative of the convoluted negotiations to achieve this goal therefore forms the third part of the chapter. These negotiations arrived, finally, at the decision to establish the British heavy water work at a Laboratory in Montreal as a joint Anglo-Canadian endeavour. The chapter thus closes with a description of the Montreal Laboratory's creation, coupled with a more granular analysis of the processes of Anglo-Canadian interaction by which this came to pass. The core narrative related in these four sections is this: that as a result of the MAUD Committee's investigations the United Kingdom committed, gingerly, to a nuclear research programme of its own; that a consequence of this process was the simultaneous catalysis of the American programme; that initial co-operation between the two states was nevertheless somewhat limited, meaning that early opportunities for joint action were never realised; that a new consciousness both of the necessary scale of the programme and of the pace of the American development nevertheless prompted the British to pursue closer collaboration with the United States; that negotiations for such collaboration faltered; that the relevance of slow neutron research increased significantly in this same period; and that the combination of these factors heightened the parallel allure of Canada in the eyes of all parties involved, to the point that the British finally resolved to locate their heavy water team there, the better to anchor their nuclear relationship with the Americans.

Implementing MAUD

The MAUD committee was short-lived but astonishingly effective. Gowing thought it 'one of the most effective scientific committees that had ever existed'.[2] Its members had certainly worked swiftly: the chemist Francis Simon had prepared estimates for a separation plant as early as December 1940, and a first draft of the overall report was circulated on 26th June 1941. Only fifteen months elapsed between the first meeting at the Royal Society and the submission of the final report. The conditions in which the committee worked, and the instinctive expectations of its members, were described in the previous chapter; now its conclusions and its impact must be traced.

[2] Gowing, *Britain and Atomic Energy*, p.80

The MAUD Committee's conclusions had been straightforward, but not especially prescriptive. Having established that the uranium bomb scheme was 'practicable and likely to lead to decisive results', it was reasonable enough to conclude that work should continue on 'the highest priority', and should expand in line with the core objective of obtaining a weapon in the shortest possible time.[3] The committee's contacts with the United States and Canada had, moreover, demonstrated the potentialities of co-operation with colleagues across the Atlantic, where industry and academia were not so hard-pressed and where the exigencies of the home front could not be so keenly felt. Anglo-centric instincts aside, it made sense that the existing collaboration be maintained and, where appropriate, expanded. This, however, was almost as far as British policy extended. There was initially no set programme, no definite administrative structure that the work would follow, no agreed pattern for governmental/ministerial oversight, and, crucially, no policy for inter-governmental collaboration. These were all introduced piecemeal in the coming months, as much in response to external stimuli as in execution of any unified plan or vision.

Although its output was almost universally referred to as 'the MAUD Report', singular, the MAUD Committee in fact produced two distinct reports – one on the use of uranium for a bomb, the other on its use as a source of power. The distinction was a significant one, reflecting a clear (but as it proved, inaccurate) assumption that the two applications of fission could be straightforwardly disaggregated. The reports' conclusions were rigorously supported and for the most part proved 'uncannily good',[4] but there was one significant lapse: the assessment of the potentialities of heavy water was flawed. Having determined, rightly, that only a fast neutron interacting with a uranium-235 nucleus within a critical mass of sufficiently enriched uranium could produce an atomic explosion, it was assumed, wrongly, that the slow neutron interactions studied by Halban's heavy water team could have no direct military application. As it was, the power report acknowledged the probability that one of the fission products of heavy water reaction, a new isotope of mass 239, would prove to possess fission properties similar to U235, but made relatively little of the implication that this isotope (that is, plutonium-239) might prove useable in a bomb. Access to better information from the United States might have made a difference here, for work at Berkeley had already begun to demonstrate that the element bore comparison with, and indeed superseded, uranium-235 in terms of fissionability.[5] MAUD recommended only that a small programme at Cambridge, under Norman Feather and Egon Bretscher, should consider the fission products of a heavy water reaction; Halban and Kowarski should meanwhile be permitted to work in the United States, with the proviso that such an arrangement should not interfere with any Anglo-American collaboration on the bomb. Almost as important was the simple implication that the heavy water work, being considered practicable solely for the power application, was to be pursued with less urgency in the context of Britain's war effort. That is not to say that the work was to be abandoned: ICI's appendix to the report stressed the essentialness that Britain should press on with its development 'so that the British Empire cannot be excluded by default from future developments'.[6] It was, however, very much a lower priority, an investment against some future peacetime programme of nuclear energy research. It is in this long-term context that the initial interest in sending Halban and his team to Canada should be viewed.

[3] MAUD Committee Report, July 1941, AB 1/347 (TNA)
[4] Gowing, *Britain and Atomic Energy*, p.82
[5] *cf*. Gowing, *Britain and Atomic Energy*, p.80
[6] Appendix VI to MAUD Report, AB 1/347

Two other implications of the MAUD report should also be noted. The most essential was the simple expectation that Britain should function as an independent nuclear actor. Any recommendation for co-operation with the United States was secondary to the core assumption that Britain *would* pursue the work, with or without partners; as Gowing noted, 'Britain's conception of itself as a nuclear power was born out of this early work'.[7] A subordinate implication was that the report was, by its very nature, destined to pass from the hands of scientists into the hands of administrators. A question of hitherto purely scientific speculation thus became a matter of government policy. So far as the preference still lay with the scientists, their instinct on questions of security and international collaboration was generally internationalist – recall the high proportion of refugees, émigrés and (notional) enemy aliens amongst the MAUD contributors – and thus generally inimical to the practices of wartime secrecy and government control. It was inevitable, though, that questions of high policy would pass out of the hands of the scientists, and equally inevitable that those to whom the great decisions would fall would be less cognisant of the minutiae of the physics involved than those who had first done the work. For the latter, it was to be an uncomfortable realisation.

The completed MAUD reports entered the machinery of the Ministry for Aircraft Production (under the aegis of which MAUD had been constituted) on 29th July. Their formal recipient was David Pye, who as MAP's Director of Scientific Research had been the committee's effective sponsor. Pye submitted the reports to the Minister for Aircraft Production himself, John Moore-Brabazon, who in turn passed on the task of detailed appraisal to the Scientific Advisory Committee, under Lord Hankey. It is indicative of the somewhat relaxed pace of the MAP bureaucracy that this journey took a full four weeks. Moore-Brabazon had asked that the Scientific Advisory Committee dispassionately consider the growing scientific consensus amongst MAUD members that the uranium work could prove to be 'of very great military value'.[8] Their task was to make concrete, actionable recommendations with an eye to longer-term strategic implications as well as to immediate war-needs. This obligation to adopt a dual perspective, addressing both the immediate and long-term implications of uranium fission, was emphasized in a personal letter to Hankey which Moore-Brabazon sent alongside his official bestowal of the report; Moore-Brabazon told Hankey that he felt 'an exploration of the Isotopes of Uranium is well worth doing from a civilisation point of view apart from that of war' – a consideration which he felt would make the expense of a British facility worthwhile (albeit only 'eventually'; no immediate plan was required).[9] He also noted that if the bomb proved a practical proposition, there were significant implications for future world order, and for Britain's position therein:

> I think if America and ourselves are going to control and police the world the possession of such a bomb would give us overwhelming superiority of striking power, without keeping up an overwhelming air force. Nor would it be possible for any other nation to hunt along the same lines without us being aware of it, and being able to stop such a thing in time[10]

[7] 'Gowing, 'Britain, America and the Bomb', p.34
[8] Minister of Aircraft Production to Hankey, 27th August 1941, AB 1/37 (TNA)
[9] Ibid.
[10] Ibid.

Several intriguing glimpses of an as-yet nebulous post-war grand strategy are in view here: that Britain and America should be the joint guarantors of world peace; that the atom bomb would enable them to fulfil such a role without the vast expense of absolute aerial supremacy; and that other states would be prevented from developing the same capability. The assumption that conventional air power could win wars unsupported had not yet been disproven by experience;[11] nor had the great engineering challenges of weaponization and delivery been solved. More will be said in Chapters Five and Six on the actual experience of post-war planning: for the time being it is enough to recognise that there was little doubt that Britain would ultimately obtain nuclear facilities of her own – and that a joint Anglo-American world order, grounded in nuclear co-operation, was the hoped-for outcome of the conflict.

The scientific advisory committee concluded that the bomb project should be regarded as 'a project of the very highest importance' and that '[a]ll steps should therefore be taken to press on with the work as rapidly as possible'. A pilot plant for separation should be constructed in the UK, and it was acknowledged that there were technical arguments in favour of constructing another pilot plant, to be followed eventually by a full-scale plant, in Canada. The power aspect meanwhile should be seen as a long-term project, but should be pursued in close collaboration with the United States and Canada.[12] These conclusions amounted to a framework for a structured programme: a new organisation was to be created encompassing the power and bomb projects alike, with the latter as the priority. Other actions had, however, been taken in parallel. Whilst the committee were still deliberating, Churchill had already concluded that action must be taken. On 30th August he minuted that 'Although personally I am quite content with the existing explosives, I feel we must not stand in the path of improvement, and I therefore think that action should be taken…'.[13] Whether a sense of irony or incomprehension shaped Churchill's phrasing here is unclear, but his subsequent orders spoke eloquently enough of his support: he nominated Sir John Anderson as responsible minister and requested the Chiefs of Staff Committee to express a view. This they did on 3rd September, urging that the programme be based in the United Kingdom – evidence of an early digression from the civilian authorities' impulse towards nuclear partnership: the military impulse was to hold the secret and the capability as close as possible.[14]

Churchill's nomination of Anderson as responsible minister set in motion what became a lengthy transition process for British nuclear research. As the SAC had recommended, responsibility for the work was transferred from MAUD and its parent ministry to a new organisation within the Department of Scientific and Industrial Research (DSIR). This new entity, given the purposefully nondescript codename 'Tube Alloys', would take over and reorganise the university work superintended by MAUD. A new leadership team was introduced, headed by Wallace Akers, Research Director of ICI. Akers' character proved apt for the role, though his background ultimately did not: his association with British industry raised American hackles at crucial stages in the negotiations.[15] A key consequence of the transition to DSIR – and more generally to a new phase of activity – was that such a move brought real discontinuity: personnel who had been intimately involved in the MAUD deliberations became detached from the new programme, and

[11] *cf.* Richard Overy, *The Bombing War: Europe 1939-1945* (London: Penguin, 2014)
[12] Gowing, *Britain and Atomic Energy*, p.105
[13] Churchill to Ismay, 30 Aug 1941, PREM 3/139/8A (TNA)
[14] Gowing, *Britain and Atomic Energy*, p.106
[15] See Chapter Three.

individuals with little or no prior exposure to the work found themselves increasingly responsible for its direction. The result was that not every initial assumption identified in the previous chapter was carried over into the Tube Alloys programme, while some new principles – including a strong political emphasis on British control of the field – were introduced.

The process of putting organisational flesh onto MAUD's advisory bones occupied much of the last half of 1941. The news of what was to happen – including the fact that MAUD was to be wound up – was broken to committee members in October. Their varied reactions reflected the range of possible interpretations of the emerging programme. Mark Oliphant was, as ever, swift to venture an opinion. Having learnt of the new organisation, and that he was essentially superfluous to it, he wrote straight back to express 'very serious misgivings'. He particularly objected to the leadership of the programme passing into the hands of 'commercial representatives' (that is, Akers and his lieutenant Michael Perrin, also of ICI), as well as criticising the ambiguous policy towards the Americans, who Oliphant understood were to be left uninformed of future developments.[16] This 'full-throated' protest was, however, swiftly muted, in part through the good offices of Chadwick and Edward Appleton of DSIR, in part through meeting Akers in person.[17] It is therefore wrong to suggest, as some have, that Akers' appointment precipitated a particular breach between Oliphant and the new organisation.[18] Oliphant's detachment from Tube Alloys was a function of his own research trajectory rather than any particular animus against him.

Efforts to tie up the loose ends of the MAUD days continued into late December. One of the last tasks was to account for the mass of sensitive papers which the committee had circulated around the country. Most were either returned or destroyed, but a handful were retained by their initial recipients against some future need to return to the issue. Oliphant, for example, held on to the papers he had been issued, on the grounds that 'my interest in the problems considered by the M.A.U.D. Committee is very deep, and I am continuing my relations under the new arrangement' (which was only tenuously accurate).[19] From an information management and security perspective, Tube Alloys could hardly be said to have begun with a blank slate. Around the notionally secure organisation swirled a constellation of associated scientists with substantial technical knowledge of the nuclear project. At least one of these – Mark Oliphant – would soon form a conduit for the transmittal of relevant information outside the United Kingdom, as Chapter Five will emphasise.

The Increasing Significance of the United States

Throughout the life of the MAUD committee the idea that nuclear research might ultimately centre on American rather than British leadership had not really been entertained. British productivity in this period outstripped American by a significant margin, owing chiefly to the 'intensity and unity of purpose'

[16] Oliphant to Appleton, 27th October 1941, AB 1/157 (TNA)
[17] Gowing, *Britain and Atomic Energy*, p.110; Appleton, Minute, 7th November 1941, AB 1/243; Chadwick to Oliphant, 10th November 1941, AB 1/63; Akers to Oliphant, 22nd November 1941, AB 1/63; Oliphant to Akers, 25th November 1941, AB 1/63 (TNA)
[18] *e.g.* Darren Holden, 'The Indiscretion of Mark Oliphant: How an Australian Kick-started the American Atomic Bomb Project', *Historical Records of Australian Science,* 29:1 (2018)
[19] Oliphant to Thewlis, 30th December 1941, AB 1/63 (TNA)

demonstrated by MAUD, and the American organisation's corresponding lack thereof.[20] Yet the British had not been indifferent to the idea of collaboration with external partners: they had sought it, welcomed it, and the MAUD report had endorsed its continuance. A connection with Canada had already been formed, via the NRC.[21] Such collaboration was easily established, thanks to the Commonwealth connection, and the nuclear work took its place alongside parallel collaborative arrangements on, *inter alia*, radar, sonar, explosives, propellants, and chemical and biological weaponry.[22] Building collaboration with the United States required a more active effort. The initial vehicle for Anglo-American scientific co-operation was the British Central Scientific Office (BCSO), led by Charles Darwin. This body, which was later renamed the British *Commonwealth* Scientific Office, in recognition of the attachment of Dominion representatives, eventually became the host organisation for the British nuclear research contingent in North America: from 1943 onwards, BCSO provided useful cover for James Chadwick and his administrative staff, at the slightly elevated risk of secret information being exposed to Commonwealth personnel.[23] At this point, though, it served only as a more formal version of A.V. Hill's earlier function as a general clearing-house for scientific interchange.

BCSO's existence as a pre-existing conduit for such interchange made it natural that it should become a focal point for the articulation to the Americans of the ideal of transatlantic nuclear co-operation which the British had held almost from the outset. In June 1941 Darwin went so far as to broach, informally, the idea of British personnel (Chadwick and Thomson) being 'transplanted' to the United States. The response, however, was lukewarm. Vannevar Bush, to whom Darwin had made the suggestion, acknowledged his theoretical ability to appoint non-Americans to the NDRC, but stressed that he had thus far deferred to the military authorities in not having done so. An exception might possibly be made for someone as exceptional as Chadwick, but it would be far less likely for someone like Halban (Darwin detected 'a profound distrust of the reliability of Frenchmen – and I suppose a fortiori of a French-naturalized-Austrian').[24] A month later Darwin again informed London of his conversations, writing now to Hankey, whose committee was considering the MAUD report. This time it was the Americans venturing a proposal that included the suggestive idea that the work should not be treated as 'merely co-ordinated research' but rather 'as a joint project for the two governments'.[25] The Tube Alloys leadership can hardly be said to have leapt at this opportunity. Only in March 1942 was any acknowledgement made of the suggestion, and even then the response was essentially dismissive. (The timing here lends credence to Gowing's supposition that it was Darwin's return to Britain which precipitated the belated British response;[26] it seems often to have been the case that individuals with closer experience of the American organisation had to act to prompt the London organisation to act). Unproductive though it was, Darwin's relaying of Bush and Conant's suggestion at least highlights two important points. First, the sheer peripherality of Halban's heavy water work at this stage is evident in the fact that Darwin, in suggesting that a small mission be sent from the United Kingdom, advocated the inclusion of Halban alongside Chadwick and Simon at least in part because he would 'serve

[20] Gowing, *Britain and Atomic Energy*, p.83
[21] See Chapter One
[22] *cf.* Donald H. Avery, *The Science of War: Canadian Scientists and Allied Military Technology during the Second World War* (Toronto: University of Toronto Press, 1998), p.181
[23] Alexander King, 'Commonwealth Scientific Co-operation During World War II', *Science and Public Policy*, 14:3 (1984)
[24] Darwin to Pye, 5th July 1941, AB 1/650 (TNA)
[25] Darwin to Hankey, 2nd August 1941, AB 1/37 (TNA)
[26] Gowing, *Britain and Atomic Energy*, p.132n

as cover' to conceal the project's actual focus on fast neutrons.[27] On both sides of the Atlantic the clear emphasis was on the separation of U-235 as the swiftest, most practicable pathway to the bomb. Second, Darwin was convinced, given the scale and expense that further development work would demand, that the Atlantic must at some point be crossed, but was ambivalent as to whether the United States or Canada would be preferable: 'I think it is fairly clear that if the work is to continue it will have to be done here *or in Canada*'.[28] Note, then, that the emerging idea at this stage was that the British work might have to cross the Atlantic, more so than that the British work must be united with the American.

BCSO under Darwin thus became the first component in a mutually-desired machinery for nuclear co-operation – albeit only in the limited form of document-sharing. MAUD materials, including minutes of key meetings, were passed to the Americans through an agreed route; in return the British received 'American papers … including reports of meetings, specifications, etc.'.[29] The exchange at this stage was essentially imbalanced, with far more information passing from the United Kingdom to the United States than *vice versa*,[30] but the research taking place on either side of the Atlantic was still essentially complementary, and was seen as such by both parties. This was, in a sense, the high-water-mark for Anglo-American nuclear co-operation: it would never again be so straightforward and good-natured. For the participants, though, there seemed every hope that this level of exchange would form the basis for closer and deeper collaboration in future.

There was, however, one impediment: the American programme had yet to achieve any coherence or sense of urgency comparable to that which had gripped the MAUD Committee. Hewlett and Anderson noted that the 'Americans read avidly the reports on British research',[31] but if this were the case it had not had any noticeable effect. Indeed the lack of any obvious response to the unprecedented conclusions of the MAUD report had prompted suspicions of a blockage in the flow of information. It was in this context that Mark Oliphant made another significant intervention. His trip to North America in the late summer of 1941 was initially only incidental to MAUD's work, but ultimately provided a crucial impetus to the American nuclear programme. Thomson had written to Oliphant on 18th July 1941, shortly before the latter's departure, mentioning 'a number of things I should be very glad to have done' whilst Oliphant was in America.[32] Reading this letter in its archival context, it is clear that Thomson was in fact responding to Oliphant's prompting in issuing these instructions.[33] Regardless, Oliphant interpreted Thomson's comments as a remit 'to make enquiries in America' concerning the receipt of the MAUD papers.[34] Sure enough, Oliphant's questioning of Lyman Briggs, notionally MAUD's American contact, elicited the discovery that Briggs, whether operating from a surfeit of caution or a failure of comprehension, had not circulated the papers he had received.[35] Not content simply to have identified the blockage, Oliphant acted to circumvent Briggs, advocating for the MAUD report's conclusions with various American contacts,

[27] Darwin to Hankey, 2nd August 1941, AB 1/37 (TNA)
[28] Darwin to Hankey, 2nd August 1941, AB 1/37 (TNA) (emphasis added)
[29] Lockspeiser, Minute, 10th September 1941, AB 1/37 (TNA)
[30] *cf.* Gowing, *Britain and Atomic Energy*, pp.65-66
[31] Hewlett and Anderson, *The New World*, p.259
[32] Thomson to Oliphant, 18th July 1941, AB 1/220 (TNA)
[33] Minute, 20th July 1941, AB 1/220 (TNA)
[34] Oliphant to Dickins, 25th July 1941, AB 1/220 (TNA)
[35] Appeton, Minute, 7th November 1941, AB 1/243; Cockburn and Ellyard, *Oliphant*, p.104

including his friend Ernest Lawrence, whose championing of the cause helped persuade the American authorities to take nuclear issues more seriously. In so acting, Oliphant may well have exceeded his authority, for Thomson's limited instructions had scarcely stretched so far as to condone agitation among the Americans. The extent of Oliphant's personal advocacy is reflected in his having prepared, seemingly on his own initiative, a précis of the MAUD report for his American colleagues. Copies of this report appear not to be held in the National Archives; little wonder, perhaps, given that Oliphant's advocacy of development work in North America was essentially unsanctioned.[36] Oliphant had certainly deviated sufficiently from his colleagues' extreme caution to make valid the questioning of Oliphant's reliability from a security standpoint. (This is a theme to which this thesis will return). The letters he had sent to Lawrence about his work on uranium fission were at best unwisely detailed; at worst they represented the unlicensed transfer of extremely sensitive secret material to a foreign power. In either case, his intervention was certainly significant enough to have given rise to Szilard's memorable assessment that 'If Congress knew the true history … it would create a special medal to be given to meddling foreigners for distinguished services, and Dr. Oliphant would be the first to receive one'.[37]

Oliphant's was not the only influence on the American programme, however. In this same period the American scientists George Pegram and Harold Urey had visited the United Kingdom, and learnt much about the British programme: enough, certainly, that their reports made stimulating reading back home. Advocates of a more concerted American effort – Bush chief of all – were gaining traction. By the autumn of 1941 their victory was complete. The American government was now wholly committed to the nuclear programme, and the Americans were suddenly very keen to have interchange with the British. The catalysis of the United States work must therefore be acknowledged to have predated Pearl Harbor: the entry of the United States into the war helps account for such later features as the transfer to military control, and the immense scale of the ultimate project, but did not, of itself, bring it about.

Historians' explanations for the sudden animation of the American programme vary significantly. Some narratives focus narrowly on American experiences, emphasising domestic rather than external stimuli, with news of the British programme serving only to buttress the advocacy of Bush and his fellow-believers.[38] In others – a slight improvement – the British influence is uncritically assimilated into the accounts as one of the final influences eroding the 'dam of doubt'.[39] Hewlett and Anderson accepted the general principle that MAUD had played a part: they listed 'News from Britain' as one of the principal reasons, alongside Bush's leadership, for the intensification of American effort from July 1941 onwards.[40] (They also mention Fowler, whom they describe as 'the British scientific liaison officer in Canada', as having been an influence on Lawrence earlier in 1941).[41] At the time, the British believed Pegram and Urey's visit to have been the deciding factor. Gowing, however, argued more for the impact of the MAUD report itself on Bush and Conant, and of Oliphant's agitation on Lawrence.[42] In all likelihood there was no

[36] Cockburn and Ellyard, *Oliphant*, p.104. A second, shorter document was prepared for Lawrence p.106. One or other of these papers may have been the document to which Thomson was referring in a letter in which he expressed fear that Oliphant had communicated too much to the Americans: Thomson to Pye, 7 Oct 1941, AB 1/271 (TNA)
[37] Quoted in Rhodes, *The Making of the Atomic Bomb*, p.372
[38] *e.g.* Martin J. Sherwin, *A World Destroyed: The Atomic Bomb and the Grand Alliance* (New York: Vintage, 1977), p.13
[39] Gerard J. DeGroot, *The Bomb: A Life* (Cambridge, Massachusetts: Harvard University Press, 2005), p.28
[40] Hewlett and Anderson, *The New World*, p.43
[41] Ibid., p.33
[42] Gowing, *Britain and Atomic Energy*, p.121, p.116

single pathway. Rather, it was the confluence of each of these influences that gave impetus to Bush and Conant's own increasing sense that a more earnest effort was required. This, incidentally, seems to explain why the American accounts tend to downplay the British contribution: because it is possible to trace the programme from one particular (very early) origin, it is not considered necessary to do the same for the notionally external factor of British influence. MAUD became an additional factor in a story that begins elsewhere, rather than representing a separate origin of its own. This, with the admixture of the pervasive tendency to focus on one's own national narrative, is sufficient to explain the propensity of even very thorough authors – Richard Rhodes, *z.b.* – to have neglected the British/Commonwealth angle. It is reasonable, however, to assert that the Americans' sudden prioritisation of nuclear work came at least partly in response to the MAUD report. More specifically, it was a response to three factors associated with MAUD: first, the findings of the report itself, which were sombre and serious, and therefore supported the pre-existing inclination of Bush and Conant to take the US programme more seriously; second, the advocacy of Oliphant in agitating for the Americans to take more vigorous action, principally, but not exclusively, through the leveraging of his existing relationship with E.O. Lawrence; and third, the Pegram-Urey visit to Britain, which was a partial consequence of the British desire to engage closely with the American programme. In having pursued their research diligently, in having reached out to friendly (if not yet allied) states, and in having allowed Mark Oliphant a somewhat free (perhaps too free) rein, the British ended up catalysing not just their own programme, but the American's as well. The metaphor of catalysis is a particularly apt one, for the British did not initiate the American programme, but undoubtedly accelerated it.

With the vivification of the American programme came a renewal of American interest in collaboration with the United Kingdom. Roosevelt had written to Churchill in October (slightly *before* the full activation of the American programme) expressing a wish soon to 'correspond or converse' about MAUD.[43] This time the British envisaged an immediate response – a statement suggesting how the two nations might best collaborate, preceded by an interim assurance of British interest in full co-operation.[44] The statement was not forthcoming, and there was no evidence of any particular urgency to respond on the part of the British. On the basis of such interactions historians have ventured an implicit (occasionally explicit) critique of British policy, framed in the language of 'missed opportunity' or 'failure'. Gowing put it fairly moderately: 'the British failure to anticipate the great and very fast growth of the American project was to affect profoundly Britain's own atomic energy efforts for the next decade or more'.[45] This is accurate enough, provided failure is construed more in its passive sense – lack of success – than in the active sense of being at fault. Certainly the British 'failure' to secure full collaboration with the Americans when it was on offer was unfortunate, and its effects long-lasting, but the rhetoric of missed opportunity obscures the complexity of the situation. The British had entered into a fallow period of deliberation and consolidation at precisely the wrong time. The fact that the centre of gravity had so inexorably shifted across the Atlantic meant that the British had ceded a degree of initiative, but this was not immediately apparent. The autumn of 1941 was the period in which the United States first became a determining factor in British calculations, but this had occurred by an awkward, slightly convoluted process. The high-water mark of American interest in

[43] Roosevelt to Churchill, 11th October 1941, PREM 3/139/8A (TNA)
[44] Brook to Martin, 10th December 1941, PREM 3/139/8A (TNA)
[45] Gowing, *Britain and Atomic Energy*, p.123

collaboration came at the least optimal moment, from a British perspective, for the programme in the United Kingdom was at that point still administratively adrift, caught in a period of relative inactivity. The British were under-appreciative of the ramping up of American interest, and sceptical about committing to the US given their neutrality in the conflict: the disparity between belligerent Britain and the as-yet neutral United States seemed too great to overcome. So the moment passed. Yet this was almost immediately to be regretted, for once the true scale of American engagement with the nuclear programme became apparent, and particularly once America had entered the war, it became clear that the United States really would be the optimal partner: the scale of American industry, and the concentration of so many American and émigré scientists there made it pretty much inevitable.

Were the British refusals in 1941 a missed opportunity, then? A case of British arrogance and pride? Much has been made of this idea, as though hubris alone explains the various delays and silences, but the archives do not wholly support the conclusion. Rather they reveal that the British were labouring under a false impression, arising from earlier experience of their interactions. Recall, for one thing, that Darwin had been the first to float the idea of closer ties, and had been rebuffed. The Americans had hitherto demonstrated little sense of urgency.[46] The lackadaisical character of the American programme as the British had first encountered it – its disjointedness and complacency – conditioned the British to scepticism about the sincerity of American planning, and instilled a fatal sense of superiority in the minds of at least some of the Tube Alloys leadership. There is an irony (noted by Gowing) in the fact that British reticence was in the first instance framed in terms of security concerns, for within a year the British themselves would be driven to despair at the stringency of American security policy.[47] In mid-1941, though, the dominant tone in British discussions regarding America was one of confusion, rather than aloofness. The issue was that the fast-moving nature of the US programme from November 1941 onwards had become an impediment to the development of collaboration: British information was invariably out-of-date by the time it could be acted upon, and efforts to co-ordinate forms of exchange lapsed almost immediately. For example, at the meeting in November, the Americans had appeared to ask for recommendations as to how the American organisation should be set up.[48] By the time a reply was sent, however, the American organisation had developed to such an extent that *any* answer the British gave would have appeared hopelessly condescending. That is not to deny that many of the interactional issues which bedevilled Tube Alloys now and in subsequent years were of the organisation's own creation. If nothing else, it was poor form not to have replied sooner to American overtures through Darwin about closer integration in the summer of 1941, and it is not impossible that some individuals viewed the Americans with an unnecessarily condescending air.

The key point is this: that the primary issue in early Anglo-American nuclear relations was not arrogance or neglect but rather timing and circumstance. The different and varying paces at which the two programmes developed, and the rapidity with which the United States gained significance *vis-à-vis* the British programme, significantly hindered sincere efforts on both sides of the Atlantic to maximise co-operation. The British had catalysed the American programme, but were unable to capitalise on this early

[46] *cf*. Gowing, *Britain and Atomic Energy*, p.64
[47] Gowing, *Britain and Atomic Energy*, p.124; Chapter Three expands upon this in depth.
[48] Brook to Martin, 10th December 1941, PREM 3/139/8A (TNA)

influence precisely because of the stage which their own work had reached; worse, the ensuing negative experiences of interactions in this period inclined the Americans slightly against the idea of collaboration in the future.

The Challenge of Crossing the Atlantic

Once created, one of the first substantive actions of the new Tube Alloys organisation had been to despatch a small mission, comprising Akers, Halban, and Simon, to the United States. Their objective was to foster ties with the Americans, assess their progress and share ideas on next steps. Such trips were not trivial. No route was wholly 'safe'. Competition for space on any form of transport was high. One had to choose between a passage by boat (slow, and hazardous), on the clipper routes (circuitous, and passing through neutral territory, leaving prominent émigré scientists dangerously exposed); or via the only reasonably fast form of transport, as a passenger (in some discomfort) in a military aircraft. The risks of transatlantic travel were sufficiently grave to have driven Peierls to take special precautions ahead of his first crossing, leaving all his papers with Klaus Fuchs for safekeeping.[49] Halban suffered the most from the challenges of wartime travel: his health, which had never been great, was damaged almost irreparably by his first wartime journey across the Atlantic. His subsequent voyages would be greatly complicated by his doctors' advice against various forms of travel.[50] The tyranny of distance also made frank communication difficult. An effort by Halban to arrange a phonecall with London, for the purpose of dealing directly with his rapidly growing list of difficulties, was swiftly blocked on security grounds.[51] Throughout the war, transatlantic communication on Tube Alloys business necessarily rested almost exclusively on the slower communication pathways of cypher telegrams, the diplomatic bag, and delivery by safe hand. These constraints on travel and communication are worth highlighting for their impact on the ability of the British team to respond quickly to American and Canadian stimuli. In the frequent cases where personal discussion was thought to be the only route forward, days or (often) weeks might pass before the appropriate representative could cross the Atlantic. Although cables could pass more rapidly these too could be held up for days, and letters could go unanswered for weeks, with real and significant consequences for transatlantic relations. The inevitable delay in formulating and then communicating a response on the part of the British organisation often meant that by the time the Americans learnt of the British position on a particular issue, the American view had already changed. These inevitable delays, coupled with the rapidly changing status of the American programme, had already impeded early efforts to establish a robust Anglo-American collaboration. Now the obstacle of transatlantic communication became even more severe, for in early 1942 the thoughts of the British had at last begun to turn more resolutely to negotiation with the Americans.

The first Tube Alloys mission was considered fairly successful: their reception in America was, by all accounts, genuinely warm. The visitors were allowed, as Gowing described it, to 'to talk to everyone and see everything'.[52] A British assessment of the mission, written somewhat later and in rather more fraught

[49] Peierls to Perrin, 13th February 1942, AB 1/48 (TNA)
[50] Halban to Tube Alloys, 4th February 1942, AB 1/34(a) (TNA)
[51] Halban to Appleton, 15th April 1942; Akers to Halban, 18th April 1942, AB 1/45 (TNA)
[52] Gowing, *Britain and Atomic Energy*, p.127

circumstances, claimed almost wistfully that 'Great progress was made in working out the means whereby a dream could be converted into a practical reality'.[53] The prospects for collaboration 'seemed rosy',[54] and the need for such collaboration was becoming ever more evident. The British visitors were, however, consistently struck by the intensity with which the Americans were now tackling the problem. It was this above all that brought the British towards the acknowledgement that to achieve the 'dream' of a nuclear weapons programme would demand 'a vast industrial effort which it would be foolish to undertake in a country stretched to the utmost, exposed to aerial bombardment and even to the threat of invasion'.[55] Britain could not itself host a full programme: the work must, they began to concede, be conducted elsewhere. Where, though? The United States now seemed a natural answer, given the alluring possibility of leveraging American scientific and industrial might. This instinct was not necessarily to the exclusion of further work in Canada, where Laurence's experiments continued and where it had been thought the heavy water work might be transferred, but for a time supplanted it. There began with the Americans a complex and frequently circular series of discussions as to what forms of collaboration might be achieved. What is important to note here is that there were in effect two interlinked sets of negotiations ongoing: those relating to the uranium-235 pathway, and those relating to the heavy water work. These, it will be recalled, had been implicitly disaggregated in the MAUD report, but subsequently proved impossible wholly to disentangle. Accounts which neglect this distinction risk lapsing into oversimplification, with severe consequences for the quality of their analysis.

1942, then, was dominated by Anglo-American negotiations regarding the design of their respective programmes and the extent of their interactions. The main preoccupation of the British team was to get their fast neutron project onto a strong footing, which essentially meant locating key aspects of that work – such as the effort at separation – beyond the borders of the vulnerable and industrially constrained British Isles. A constituency in favour of such a step had, it will be recalled, formed at an early date, and their argument had only been bolstered by the rapid progress of the American programme. By the end of July, even Anderson, initially very much in favour of retaining all work within the British Isles, had been persuaded. Recognising that the Americans had been 'applying themselves with [an] enthusiasm and lavish expenditure' which Britain could not rival, he had concluded – in conjunction with his Consultative Council – that a full-scale separation plant on British lines could only be constructed in the United States, and that therefore the pilot plant must also be constructed there. This would require 'a combined Anglo-American effort'. Anderson was only a reluctant convert to this position, but had seen at last that the work conducted in the UK was 'a dwindling asset', which the British must capitalise quickly.[56] This sense of urgency never dissipated: much of the course of British nuclear policy in coming years stemmed from the compulsion to retain some degree of prominence in a field in which the country had once led. The spectre of the bomb ensured that this compulsion became existential in nature: Britain must, at whatever cost, remain in touch with the latest developments in fast neutron research.

The parallel question of what to do with Halban's slow neutron team meanwhile remained. British understanding of heavy water's potential significance had evolved somewhat since the MAUD report was

[53] TA diary of events (circa later 1943), PREM 3/139/9 (TNA)
[54] Gowing, *Britain and Atomic Energy*, p.126
[55] TA diary of events (circa later 1943), PREM 3/139/9 (TNA)
[56] Anderson to PM, 30th July 1942, PREM 3/139/8A (TNA)

published. It was clearer now that '94' would be fissile, and whilst the power application remained a live enquiry it was as a pathway to plutonium production that a reactor was now chiefly desired. This was the case on both sides of the Atlantic: the Americans were pressing on with their own programme for plutonium production, with graphite as their preferred medium rather than heavy water. The differing lines of enquiry implied complementarity rather than competition, and alongside the wider discussions about the programme's future negotiations were begun on the possibility of aligning Halban's work more closely with the American programme (implicitly by transferring Halban and colleagues to America). Diplomatic complexities abounded. First, it was feared that pressing the United States too hard on heavy water might prejudice a future effort to secure their support for uranium separation in support of the British work.[57] Then there was the problem of Halban himself: the Americans were none too keen on admitting this unknown quantity, who was not even a British citizen, into their midst. There was also the vexed question of the agreements around secrecy and patents: a British arrangement with Halban would have to precede any deal with the United States.[58] In short, the British proposal still had far too many loose ends for the Americans to feel entirely comfortable.

The British persevered, however, for on both sides a broader desire to collaborate on slow neutron research still prevailed: the physicist Arthur Compton, who headed the American slow neutron work in Chicago, was particularly encouraging. In the course of myriad discussions, supported by a voluminous correspondence, a number of possible options emerged. One suggestion was essentially to transplant a British team to the United States, operating as a separate team, paid for by the United Kingdom, 'working independently but in mutual support with [the] Americans'. The parallel suggestion was that Halban, with one or two others of the Cambridge team, should join an existing American unit at Chicago, and be paid by the Americans.[59] Halban himself favoured the former option, on the grounds that the American effort so dwarfed the British that the benefits of crossing the Atlantic – especially in terms of practical experience and exposure to American research – far outweighed any benefits of remaining in England.[60]

This was a compelling argument, but placing the whole team in the United States was necessarily contingent on American agreement, which clearly could not be guaranteed. Alternative plans might, therefore need to be laid: if the Americans refused, 'the merits of an independent team in Canada should be weighed'.[61] By the start of May two things were evident. First, the instinctive preference was clearly for some kind of collaboration with the Americans, even if it must be on American terms: the disparity in the scale of the two countries' nuclear activities was already too great for this not to be the most logical path to rapid development. Second, whilst the basing of a team in Canada was considered a possibility at this stage, it was generally held to be less desirable an arrangement than was hoped for with the Americans. The fear was that Canada simply could not compare with the United States in terms of industrial facilities. As Akers put it in a telegram on 5th May,

[57] *cf.* Gowing, *Britain and Atomic Energy*, p.73
[58] Perrin to Akers, 23rd June 1942, AB 1/701 (TNA)
[59] Halban to Akers, 1st May 1942, AB 1/34(a) (TNA)
[60] Ibid.
[61] Ibid.

> Unless such facilities are negligible we cannot see any advantage in having independent team in Canada where facilities believed practically non-existent and certainly inferior to those in England.[62]

There was one advantage that Canada held over the United States, however: it would be far more straightforward for British personnel to be deployed there. The British had received word that the main sticking point in their negotiations around placing a British team in Chicago was the 'lack of precedent for any group of foreigners to work quasi extraterritorially' on defence-relevant work within the United States.[63] Exceptions might possibly have been made, but Conant and Bush were unwilling to press the point. Various other permutations were therefore considered. There was some talk of placing Halban in an American university – Princeton, say – but Bush and Conant were increasingly unsupportive of that idea, too. The alternative to all of these was no collaboration, and a UK-based independent programme, but this now held little allure.

Remaining in England was increasingly unattractive: the programme would be too far removed from the new centre of gravity for nuclear research. Time, too, was of the essence. Immediate close collaboration with the US was the only way in which the vanishing advantage Britain enjoyed could be leveraged into longer-term progress; relocation to North America seemed to be the price of that collaboration, and if it could not be on the ideal terms at Chicago, why not on Britain's own terms in Canada? There would be disadvantages, of course. Challenges around materials and personnel would be more acute than in America's more highly developed industrial economy. The administrative problem of operating a complex project three thousand miles from London was significant. Even the wartime weakness of the pound would cause problems. The one issue that appears *not* to have loomed especially large at this stage, though, was the need to secure (and then preserve) the acquiescence and practical support of the Canadian government. The British certainly anticipated no issue on that front: 'Professor Thomson had the impression that a British paid independent unit would be very well received in Canada'. Wrote Halban:

> Since we cannot afford to make this effort ourselves, on the same scale as the Americans, it is the wisest solution that we continue our work on the American continent, allowing some of the members of the slow neutron team to have a very intimate exchange of facts and ideas with the Americans; since they can gain a lot from such an exchange they will certainly favour it.[64]

In the Americans' minds, too, the Canadian option had begun to look like a convenient way of reconciling geography with sovereignty. At any rate, Compton and his circle remained keen to find a solution, seeking to assure Halban of 'the continued desire of all of us concerned with this project to co-operate to the fullest extent with the British group', which he knew to be of importance both for the present war effort and for 'post-war developments'.[65] So the British persevered.

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[62] Akers to Halban, 5th May 1942, AB 1/34(a) (TNA)
[63] Halban to Akers, 23rd May 1942, AB 1/678 (TNA)
[64] [Halban] to Akers, 13th May 1942, AB 1/34(a) (TNA)
[65] Compton to Halban, 11th May 1942, AB 1/159 (TNA)

A further iteration of discussions then brought the roots of the Americans' hesitancy more clearly to the fore. Compton was increasingly unsure that the option still notionally favoured by the British – that of an 'independent' but closely integrated programme on American soil – could be achieved. The bureaucratic-legislative hurdles on that side of the Atlantic seemed insurmountable. This left two slightly different options: for Halban and an assistant to join the American project *in toto*, or else to establish 'an independent working organization somewhere in Canada, controlled and operated by the British Government with which… the United States could share ideas and interchange needed material'.[66] A year or so previously the first option, of Halban alone (or with a colleague or two) joining one of the American teams, would have been a most welcome offer, but the proposal had little now to recommend it: such a step could hardly have represented a reasonable return on more than a year's effort by an entire team at Cambridge in a field which now promised weapons-relevant results, and the more astute (or sympathetic) Americans knew it. Compton's preference was therefore now for some variation on the second option as a 'reasonable compromise'; it would not, he thought, be difficult to establish quick and complete interchange.[67]

This was sound if slightly optimistic analysis. The British, too, could see that Canada would offer many of the advantages of proximity without the hindrances of extraterritoriality. The convergence on Canada as a positive alternative to the increasingly unworkable idea of sending Halban to the United States can therefore be dated to approximately this point, though for the British it was really a return to an idea that had occurred to them long before. The difference was that in the early days of the MAUD Committee the idea of sending Halban overseas had been given serious consideration on the basis that it was interesting in the long-term but peripheral to the main line of enquiry; its revivification stemmed now from the importance which the work had gained and the associated desire to parlay that asset into a closer relationship in the field of fast neutron research.

Canada nonetheless suffered in comparison with America: the comparative weakness of Canadian industry was always an argument against basing major endeavours there rather than in the United States. Akers clung to the hope of an American solution well into the summer, reassured by the fact that the Americans had continued to make encouraging noises: 'We cannot have too much interchange on this matter', Bush had written in early September.[68] Akers also harboured doubts about the ability of the heavy water work to secure American collaboration. He was concerned that it might prove too discrete, too easily separable from the main thrust of the weapons programme. The risk, in his view, was that 'unless we can be quite certain that the Americans will really regard the team in Canada as being part of their own team, but domiciled in Canada to satisfy certain political scruples', the programme might become sidelined, separated both from the American work and from whatever remained in the United Kingdom.[69] Ranged against these fears – which later events proved, if not prophetic, then at least perceptive – was the increasingly powerful argument advanced by the likes of Darwin that a firm commitment to work in Canada would be 'politically valuable' as evidence of a joint effort.[70]

[66] Compton to Halban, 11th May 1942, AB 1/159 (TNA)
[67] Ibid.
[68] Bush to Anderson, 1st September 1942, AB 1/207 (TNA)
[69] Akers to Perrin, 11th June 1942, AB 1/357 (TNA)
[70] Darwin to Akers, 23rd July 1942, AB 1/357 (TNA)

Although actuated in part by the prospect of months more tortuous negotiation with the Americans, and the increasing risk of their direct refusal to accept a British team, the *volte face* to Canada as a preferable destination for the Halban team was not primarily a defensive decision. On the contrary, the Canadian option represented a significant opportunity. If they moved quickly, Britain could assume leadership of almost the entire slow neutron project – certainly the heavy water aspect – at the cost only of some preparatory work in Canada.[71] Britain would thus be well-situated to argue for a broad-based programme of interchange. The British had thus arrived at the essence of a strategy: to pursue an Anglo-Canadian endeavour on heavy water as a demonstration of the practical value of the British programme, and of the extent of British commitment to it, whilst remaining utterly committed to the achievement of some form of collaboration with the United States on uranium separation and weapons design.

(Finally) Embracing the Canadian Option

Despatching Halban to Canada had become preferable from about August 1942 onwards, as the result of a process of triangulation between British and American policymakers. Earlier exchanges between Britain and Canada had lain some of the groundwork for their collaboration (recall the initial interactions with NRC officials detailed in Chapter One), but for Britain to pursue true developmental work in Canada would be altogether different from the simpler connections that had thus far been forged between Tube Alloys and the NRC. It was not even entirely certain that Canada would be capable of supporting such an endeavour, nor were the Canadians necessarily *au fait* with British thinking, not having been party to the negotiations with the Americans. If the British were serious about the prospect of pursuing the heavy water work in Canada – and there were now increasingly strong political reasons why they should be – it was clear that a formal request must be made of the Canadians and a great deal of exploratory work must be conducted. Anderson duly wrote to the British High Commissioner in Ottawa, Malcolm MacDonald, who was already acquainted with aspects of the Tube Alloys programme, in order to inform him of the request that was to be made of the Canadians. Anderson's letter and its draft between them give the lie to the suggestion that the British approach to Canada was seen as a fall-back option in the face of American reluctance to collaborate. Both documents emphasise the active intention of transferring some or all of the fast neutron/U-235 work to the United States. Regarding plutonium, they acknowledged the American focus on graphite as likely the quickest (and therefore best) route to weapons-relevant quantities, but still argued for the parallel value of the heavy water route as a more time-consuming but more efficient pathway. A handwritten amendment to the draft reads: 'There is not, therefore, the same urgent need to bring Dr. Halban and his team to U.S.A., in the same way as we propose to bring the U 235 team',[72] but there would certainly be benefits in geographical proximity; hence the idea of transferring the work to Canada, which had already been widely discussed. Canada, as the final letter makes clear, possessed 'many of the advantages and few of the disadvantages' of the United States. Halban and his team would be 'out of the picture' if they remained in Britain, but the Americans' single-minded pursuit of the graphite pathway would likely mean that Halban's team would receive less than adequate support. Basing Halban in Canada therefore had much to recommend it: the advantage of proximity to and co-ordination with the American graphite work (not to

[71] Halban to Akers, 23rd May 1942, AB 1/159 (TNA)
[72] Anderson to MacDonald, 5th August 1942, AB 1/207 (TNA)

mention the anticipated joint fast neutron endeavour) without the disadvantage of competing directly for support within the United States, and with the added allure of greater independence for the British programme.[73]

The British expectation at this point was that Halban and his team would transfer to Canada 'at any rate for the duration of the war' in order to 'join up with Canadian scientists and make a joint Anglo-Canadian team'.[74] Anderson had drily noted to MacDonald that the proposal 'will not come entirely as a surprise to the Canadians',[75] and the alacrity with which Mackenzie engaged with the British proposal proved the point. Mackenzie's diary, like Halban's in the National Archives, betrays signs of non-contemporaneity,[76] but nevertheless demonstrates the rate at which discussions progressed. At the start of September the United Kingdom pressed for definite answers from the Canadians as to the transfer of the Halban team to Canada.[77] Halban was tasked in September 1942 with investigating the arrangements necessary to base his team in Canada.[78] Discussions about how the scheme could be arranged on a practical level began on 24th September, and by 26th September the two parties had agreed to Mackenzie's proposals around structure and collaboration.[79] A memorandum was duly prepared. This unassuming two-page document, drafted by Mackenzie, outlined the administrative and reporting structures the Canadians proposed.[80] General and intergovernmental policy issues would be decided jointly by the Canadian minister C.D. Howe and the British High Commissioner Malcolm MacDonald, whilst administrative control would be unified under the NRC. On a day-to-day basis, this would be a Canadian organisation, an arrangement which Mackenzie felt would provide 'maximum secrecy and flexibility together with government control and responsibility'.[81] It was also thought – naïvely, as it would later prove – that the NRC would prove an administratively flexible host.[82] A committee chaired by Halban, with J.F. Jackson of DSIR as secretary, would have a degree of freedom to direct scientific and technical policy, and would report directly to the NRC president; that is, to Mackenzie. British voices predominated: of the five named members, only G.C. Laurence was Canadian. Yet the memorandum further stipulated that

> while informal reports and communications may pass directly between the United Kingdom members of the team and the High Commissioner and the Department of Scientific and Industrial Research, all formal reports, negotiations and transactions will pass through the office of the President of the National Research Council for approval or decision.[83]

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[73] Anderson to MacDonald, 6th August 1942, AB 1/207 (TNA)
[74] Akers to Huggett, 10th September 1942, AB 1/47 (TNA)
[75] Draft, Anderson to MacDonald, 5th August 1942; Anderson to MacDonald, 6th Aug 1942, AB 1/207 (TNA)
[76] *cf.* entry for 16th December 1942. Internal evidence – *e.g.* references to 'Hull Bantine' for 'Halban team' (17th August 1942) suggest the LAC version was dictated from an original after the fact. If so, this would have permitted the insertion of additional comments. RG77-D-1-b. Box 283 'Extracts from Dr C.J. Mackenzie's personal diary of items relating to atomic energy' (LAC) (hereafter: 'CJM diary').
[77] CJM diary, 2nd September 1942
[78] Akers to Halban, 8th September 1942, AB 1/556 / AB 1/47 (TNA)
[79] CJM diary, 25th & 26th September 1942
[80] 'Memorandum on proposed procedure for a co-operative project (U) as between the Governments of the United Kingdom and Canada', September 1942, AB 1/275 (TNA)
[81] Mackenzie to Appleton, 2nd October 1942, RG77-D-1-b. Box 284 'Radiological Research. Policy, Vol. 1' (LAC)
[82] Gowing, *Britain and Atomic Energy*, p.189. The later administrative issues at Montreal are dealt with in Chapter Four.
[83] 'Memorandum on proposed procedure for a co-operative project (U) as between the Governments of the United Kingdom and Canada', September 1942, AB 1/275 (TNA); copy in RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)

All parties seemed content with the proposed arrangements. Mackenzie was optimistic, telling Appleton that 'if we can make satisfactory arrangements for co-operation with the Americans … the plan of operation suggested above will work very well in Canada'.[84] Securing the recquisite co-operation with the Americans, of course, was at once the entire purpose of the endeavor and the great variable overshadowing it. For the time being, however, all augured well: when details of the proposed set-up in Canada were shared with the Americans, Conant, Urey and Compton all declared themselves in favour and promised 'all possible collaboration'.[85]

The senior figures from Britain and Canada met on 12th October 1942 to seal the plan. They first agreed that the slow neutron work should be transferred to Canada 'regardless of the future domicile of the Fast Neutron Team'. Three justifications for the transfer were given:

a) The highly co-operative attitude of the Canadian Government.
b) Willingness of the U.S.A. to give priority, on formal request, for essential raw materials and services.
c) The advantage of proximity to the U.S.A. scientific and industrial development work in the same field.[86]

Mackenzie's organisational outline was then approved, subject only to minor amendments – one granting the technical committee a right to speak directly to the policy committee (that is, Howe and MacDonald) should some issue arise in their relationship with Mackenzie, and the other stipulating that if a British fast neutron team were to be established in the United States, then all liaison work would take place through that office – evidence of the relative importance of the two strands in British eyes.[87] Having waited impatiently for the British formally to commit, Mackenzie was now demonstrably keen to get going, almost to the exclusion of the Tube Alloys representatives with whom he was supposed to be working.[88]

In November the twin processes of recruitment and site selection began. On the personnel front, Canada faced a 'dearth of talent' in relevant fields,[89] not least because of the centripetal effect of talented researchers gravitating to universities in the metropole (compounded by competition from institutions in the United States). Much was therefore made of the few exceptional younger candidates Canada could offer.[90] The British, meanwhile, noted that personnel were to be selected for involvement in every section of the laboratory, so that 'when the project has been brought to some suitable stage it will be possible for the English team to return with complete information and experience' – early evidence of the British expectation that there would eventually be a nuclear project located within the British Isles – 'while leaving a similarly self-complete team of Canadians to carry on the work here'.[91]

[84] Mackenzie to Appleton, 2nd October 1942, AB 1/273 (TNA)
[85] Halban and Jackson to Akers, 4th October 1942, AB 1/357 (TNA)
[86] Meeting, 12th October 1942, AB 1/62 (TNA)
[87] Ibid.
[88] CJM diary, 30th October 1942; Akers to Perrin, 5th November 1942, AB 1/123; [Halban] to Akers, 25th September 1942, AB 1/123 (TNA)
[89] Avery, *The Science of War*, p.183
[90] Mackenzie to Shrum, 13th November 1942, RG77-D-1-b. Box 283 'Personnel: Chalk River'. (LAC)
[91] Jackson to Appleton, 30th November 1942, AB 1/123 (TNA)

By December 1942, then, 'the prospects of the Anglo-Canadian project appeared to be excellent'.[92] Temporary accommodation had been secured (in the just-completed medical wing of the *Université de Montreal*), the basis of a very capable Anglo-Canadian scientific team had been recruited or transferred, and although many materials were still lacking they were at least in transit.[93] There had been some early disappointments. Practical problems crossing the Atlantic 'were legion'.[94] Reams of correspondence were dedicated to such vexed issues as the procuring of appropriate priorities for travel; the sourcing and delivery of materials and equipment; and the contentious question of whether and on what terms laboratory members might be permitted to bring their families with them. Nor was all well in terms of staffing. By 1942 relations between Halban and Kowarski had broken down seemingly irrevocably, leading in turn to difficulties with the wider Cambridge team. Personnel around Kowarski had begun laying down conditions on which they were willing to participate; a number of solutions were suggested, involving various distributions of personnel between Cambridge and Montreal. Yet as Akers pointed out, it made little sense to split the Cambridge team, since the whole advantage derived from its completeness; this had been one of the principal objections to the earlier suggestion that only two or three of the heavy water team should join the American organisation.[95] Thus it was that Akers was still thrashing out details of the transfer and still attempting to resolve the difficulty with Kowarski and the Cambridge team in the final weeks of December.[96] The Laboratory was certainly not to be fully operational by the first of January, as the Canadians had fondly hoped. For all these difficulties, however, there was still much cause for contentment. Halban took stock just before Christmas; 'so far', he wrote, 'I am extremely pleased about the attitude of the Canadians'.[97] The project showed every prospect of becoming a genuine collaboration. The financial arrangements made between the governments left each government responsible for the salaries of their own personnel with all other costs picked up by the Canadians.[98]

How, then, to characterise the processes by which the nuclear laboratory at Montreal came into being? It would be wrong to assume a dynamic of subservience, as though the Canadians lacked agency vis-à-vis the United Kingdom. Canadian acquiescence was never taken for granted by the British. Appleton strongly emphasised the 'need of Canadian approval even to details'.[99] Canadian consent was sought for the regular despatch of reports and minutes to London and the right of the British Technical Committee to pass comment on the programme pursued in Canada, occasionally in such a tone as implied the melding of two fully independent programmes.[100] Such steps would hardly have been necessary had this been simply an act of imperial imposition. The Commonwealth connection was manifested, instead, in a subtler expectation – of common interests and fellow-feeling.

This distinction is not immediately evident in Canadian historical writing, which has tended to presuppose a hegemonic intent on the part of the British policymakers. Donald Avery notes that 'Not surprisingly, the British team dominated the administrative and senior scientist positions'.[101] The statement is broadly

[92] Buckley, *Canada's Early Nuclear Policy*, p.25
[93] Ibid., p.25
[94] Gowing, *Britain and Atomic Energy*, p.192.
[95] *cf.* Akers to Halban, 19th May 1942, AB 1/357 (TNA)
[96] Akers to Perrin, 20th December 1942, AB 1/631 (TNA)
[97] Halban to Perrin, 22nd December 1942, AB 1/123 (TNA)
[98] Costley-White to Appleton, 1st December 1942, AB 1/273 (TNA)
[99] Perrin to Akers, 14th December 1942, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[100] The relevant correspondence is in RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[101] Avery, *The Science of War*, p.184

accurate, but the implication is a little uncharitable. The initial organizational structure of the Laboratory certainly reflected its Cambridge origins, but also left space for Canadian initiative and leadership, initially in the person of Laurence, but expanding to others as the work progressed and the Canadian recruits gained experience. The NRC's gain, in terms of access to information, placements for Canadian scientists at all levels of experience, and in nebulous future prestige, was greater than its administrative sacrifice. Indeed, there had been concerns on the British side that the proposed arrangement left rather too much in the hands of the Canadians.

With the establishment of the Montreal Laboratory Canada had, for better or worse, become fully enmeshed in the British nuclear programme. It had happened not simply by accident, or by design, but by the combined workings of those two forces. Timing had been an important early factor. Because the catalysis of the American programme coincided with the consolidatory phase in the British programme, straightforward bilateral co-operation had proven impossible to achieve. Assessment of the potentialities of slow neutron reactions meanwhile changed, increasing the importance of the endeavour. The intention throughout was that the British fast neutron work should be conducted in the closest possible communion with the Americans. For this reason, the separation work was *not* transferred to Canada (in spite of Simon's pleading to the contrary: 'Do you think it really quite hopeless to build our plant in Canada?').[102]

Nor would it be appropriate to characterise the embrace of Canada necessarily as a setback to British policy. Placing Halban *et al* in Canada had not been Tube Alloys' first-choice policy, but instead represented a neat circumvention of the increasingly insuperable obstacles which had stood in the way of transplanting the British work to the United States. To view this only as a 'retreat to Canada', as Holmes has, would, however, be a mistake.[103] The British had no intention of retreating overall: almost the entire purpose of the transfer of the heavy water work to Canada was to consolidate British nuclear assets as advantageously as possible *vis-à-vis* the United States. The British took a holistic view of the project, envisaging the Canadian work as a facet of the wider allied effort for which they still hoped. This theme was echoed by the Americans themselves. When Bush wrote to Mackenzie on 1st October he expressed his pleasure at the planning for the Anglo-Canadian scheme 'for I feel that this will be of distinct aid in proceeding with the discussion of the broader phases of the relationship on this subject'.[104] Six weeks later, with the Canadian scheme now confirmed, Conant again wrote 'I am sure that all recognize that we must consider Dr. Halban's undertaking in Canada as one aspect of the total effort'.[105]

Yet all was not well. Largely unnoticed, storm-clouds were gathering. For all that the Americans had been supportive of the move to Canada, there seemed little prospect of their joining the laboratory: for the Canadian organisation to become truly tripartite was considered 'impossible for political reasons'.[106] This necessarily introduced a degree of organisational and psychological distance between Montreal and the American facilities. Still more seriously, Canada's entire involvement in nuclear research depended upon the provision of heavy water for the Montreal Laboratory, which meant in turn that Britain's sole

[102] Simon to Akers, 8th September 1942, AB 1/357 (TNA)
[103] Holmes, *The Shaping of Peace*, p.200
[104] Bush to Mackenzie, 1st October 1942, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[105] Conant to Mackenzie, 17th November 1942, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[106] Akers to Perrin, 11th December 1942, AB 1/357 (TNA)

established interaction with the United States nuclear programme rested upon the procurement of a material of which the only accessible stock lay in American hands. It was an ominous dependency.

Conclusion: Canada as Leverage

The long-term consequence of the establishment of the Montreal Laboratory, at least insofar as the relationship with the United States was concerned, was that the British became 'junior partners in the atomic project they had launched'.[107] That the nuclear centre of gravity must shift across the Atlantic was a question of macro-economics and the military-industrial *longue durée*, but the character of that transition, and its timing, had everything to do with personal interactions and accidents of timing.

The catalysis of the American programme was a partial consequence of MAUD's own endeavours, the committee's instinctive early glances across the Atlantic having planted the idea of collaboration on both sides of the Atlantic. These preliminary contacts formed the context for Mark Oliphant's intervention, and for associated interactions on both sides of the Atlantic. The sum of these interactions was the infusion of a sense of confidence into the American organisation – confidence which had been hard-earned by the MAUD Committee, but which was gladly gifted to the American organisation. The Americans, reaping where they had not sown, and blessed with an economic and industrial base unpressured by war, were thus able to leapfrog the British programme. The window of opportunity in which an accord for full collaboration (or even the merger of the two programmes) could be agreed was narrow, and the scope for an agreement has been overstated. The high-water mark of American interest in collaboration came at the least optimal time, from a British perspective, for in the summer of 1941 the British programme was administratively adrift, caught in a period of (relative) dormancy, under-appreciative of the ramping up of American interest, and sceptical about the merits of intertwining a crucial project with a neutral state. To progress beyond personal contacts and the *ad hoc* exchange of papers nevertheless proved more challenging than anticipated, and the peak interest of one party in closer ties never quite coincided with the other's. Part of the problem was that the British were aiming to consolidate two disparate lines of research at the same moment that the United States began most earnestly to compartmentalise. Instead of an easy accommodation the British were forced to negotiate, hard, for closer ties with the American project – this in spite of the fact that the United States was now a belligerent. Alliance, however, counted for little in the world of nuclear negotiation. It is pleasingly aphoristic to assert that 'Nothing promotes co-operation between individuals or nations more surely than the existence of a common enemy',[108] but it would be far truer to acknowledge, as Victor Rothwell put it, that ''To depict British-American relations from Pearl Harbor onwards as a story of continuous friendship, mutual respect and monolithic solidarity would be as erroneous as anything in revisionist literature'.[109]

The complexities of conducting negotiations on two distinct but inter-related lines of enquiry very nearly overwhelmed British policymakers, and have continued to befuddle historians ever since. Tasked with explaining the fact that collaboration with the United States was not attained, and that Canada was so swiftly

[107] Gowing, 'Britain, America and the Bomb', p.36
[108] King, 'Commonwealth Scientific co-operation', p.152
[109] Victor Rothwell, *Britain and the Cold War, 1941-1947* (London: Jonathan Cape, 1982), p.6

embraced in later 1942, Canadian historians have sought to cut the Gordian knot by framing the creation of the Montreal Laboratory in terms of British defeat and Canadian acquiescence. John W. Holmes – a tangential participant in Canadian nuclear history, as well as its historian – wrote of the British looking to Canada 'for help and sanctuary', seeing the Dominion as simply 'a good alternative' in the face of American rebuffs,[110] but such an interpretation ignores the underlying premise of the British policy that building relationships and demonstrating capability in the field of slow neutron research would bolster British efforts to remain abreast of developments in fast neutron research too (not to mention the process of triangulation by which the British and Americans arrived largely simultaneously at the idea of the Canadian project). For London, the principal utility of Canadian involvement in nuclear affairs was as a means of preserving the British conception of the nuclear programme. Canada thus gained effective custody of part, but only a part, of the British nuclear programme: 'a curious twist of wartime fortune',[111] yes, but one grounded in existing bonds and rational policy calculation.

By the same token, Gowing's suggestion that Canada agreed to provide facilities 'simply in order to help Britain'[112] seems uncharacteristically lacking in nuance, for the archival record in both Canada and the United Kingdom makes clear the alacrity with which Mackenzie embraced the British proposal. That the Canadian government was constitutionally and emotionally inclined to render assistance to the British was certainly a factor, but this impulse was wholly compatible with the expectation of direct benefits for Canada; and at any rate altruism alone, even in the Commonwealth cause, could hardly have moved the Canadians to accept an arrangement which they though iniquitous – least of all under Mackenzie King, that zealous guardian of Canada's sovereignty.

How then had part of the British programme come to be based in Canada? Such a manoeuvre required implicit confidence in the reliability and amenability of the Canadian establishment; and yet the archival record makes clear that the British did not perceive Canada as a territory to be acted on, but as a partner – admittedly, a historically obliging one – to be engaged with. The project in Canada was not a consolation prize, still less a new departure. Clinging to the hope of a united (if not unified) allied effort, the British looked to Canada, not initially as an *alternative* to the United States relationship, but as a buttress to it. It was an arrangement satisfactory to constituencies in all three states. When enthusiasm for heavy water temporarily dimmed in the early stages, the idea of a relocation to Canada became a convenient way of handling a low-urgency project; when the characteristics of plutonium became more readily apparent, the same project became a high priority once more. Thus, counter-intuitively, the periods of minimal and maximal interest both served to propel the programme to Canada. The fast neutron work, meanwhile, was reserved to the United Kingdom as a result of the tension between the desire for independence and possession of the weapon and the desire for collaboration: unlike the heavy water work, which could be handled as a discrete project, the elements of the fast neutron work could not be disaggregated from one another and could not be safely lodged in Canada as a mutually satisfactory alternative. Whereas the positioning of the slow neutron work in Canada could be justified as beneficial to each of the parties concerned, including the American and British governments, the fast neutron work came to be seen as an

[110] Holmes, *The Shaping of Peace*, pp.198-199
[111] Buckley, *Canada's Early Nuclear Policy*, p.9
[112] Gowing, 'Britain, America and the Bomb', p.36

all-or-nothing endeavour: either a complete merger – necessarily located within the United States – or else complete independence was required. The British still favoured the former, and had gambled their main asset – the heavy water work – accordingly. In short, it was not chance, nor even mere geographical proximity, that made Canada the home of British heavy water research, but rather the deliberate, calculated elevation of an existing collaboration, for the sake of securing a greater prize.

Chapter Three:
The Road to Quebec

The previous chapter highlighted the fact that, by late 1942, the nuclear initiative lay increasingly with the Americans. This new reality had led the British to commit more firmly to a Canadian offshoot of their project than they had initially intended. In ceding the momentum to the Americans, however, they found that they had also made themselves hostage to American goodwill, which soon turned out to be in strikingly short supply. In the final months of 1942, with Britain now recognisably falling off the Americans' pace, relations with the United States began to grow fraught. In January 1943 they collapsed completely. The catalyst for this rapid deterioration was an American effort, attributed to Conant and enacted in his name, radically to restrict British interchange with the American programme, with severe consequences for the prospects of the Tube Alloys endeavour in Britain and Canada. The terms which the Americans now proposed were disastrous – 'far more stringent than either the Canadians or the British had been led to expect' – chiefly because 'they appeared to be at variance with earlier political undertakings that the British thought Roosevelt had given to Churchill'.[1] 'Thought' is very much the operative word here. As shall be seen, British attitudes to planning, collaboration, and the role of Canada, which up to this point had been formed very much by instinct, were reformed through bitter experience, as earlier expectations proved ill-founded and naïve. Exposure to adversity, some of which the British had brought upon themselves, forced the re-appraisal of British ideas as to the trajectory of her nuclear development and the part which Canada might play. It is this process of reconceptualization, and the steps taken towards the eventual reconfiguration of the joint programme as a hybrid endeavour, conceived partly as a tripartite US-UK-Canadian project, partly as a US-Commonwealth accommodation, with which this chapter is concerned.

The starting point is an account of the process by which the crisis in Anglo-American nuclear relations unfolded. The period in which it dawned on the British that the United States now held the upper hand – and must therefore serve as an influence on their nuclear own activities, including in Canada – was coterminous with that in which the deterioration of the Anglo-American collaboration first began to be felt. This was no coincidence, but rather a case of the effect highlighting the cause: it was precisely because of the Americans' rapidly improving position relative to the British programme that Groves, Conant *et al* felt empowered to loosen their end of the collaboration. Although already increasingly on the back foot in their relations with the Americans, it was the sudden presentation of stringent new conditions in early January that first made the Americans' newly combative attitude apparent to the British.

The second section delves more deeply into the logic of British efforts to articulate a coherent response to the emerging crisis, exploring the tension between rival conceptions of how best to proceed in the face of American intransigence. This was not a linear process, but rather an awkward, iterative grasping after policy, as with a mix of incredulity and incomprehension the British sought to parse the logic and politics motivating their American counterparts. Two rival policy options were articulated, which might crudely be described as *resistance* versus *acceptance*. Advocates of resistance sought to secure better terms from the

[1] Buckley, *Canada's Early Nuclear Policy*, p.25

Americans, and insure against a permanent breakdown, by redoubling and potentially expanding the British programme in Canada, whilst advocates of acceptance to secure or recover American goodwill by demonstrating willingness to subordinate Britain's nuclear interests to the greater cause of ensuring the weapon's wartime development.

Finally, the chapter follows the tortuous negotiations leading to the Quebec Agreement – a process which necessarily incorporates reflections on the changes which this period of angst and uncertainty brought about, both materially, in the form of the negotiations themselves, and psychologically, in the altered conception of Canada which external circumstances had brought about. Forced by American obduracy to reconsider the fundamentals of the Tube Alloys programme, the British considered abandoning all hope of American collaboration, but were dissuaded from doing so by the realisation that such a policy would have no support from the Canadians, on whose partnership the British now realised, for the first time, they had come to depend.

The Conant Crisis

Establishing the Montreal laboratory had neatly resolved the awkwardness around the location of Halban's team, and a steady and valuable process of information exchange was now in progress across in most of the fields with which the allies were concerned. As the year wore on, however, the quality of interaction had begun to decline, a result of greater and greater American restrictions. By late autumn, the decline in the quality of Anglo-American interactions had become noticeable, particularly around the heavy water work for which the British and Canadians were preparing. Discussions, by letter and in person, continued, but these all 'failed to achieve anything.'[2] In particular, Bush was now seeking to enforce a new basis for exchange: 'information would be given only where the recipient could make use of it during this war.'[3] This, coupled with an increasingly stringent attitude towards security antithetical to the British interdisciplinary approach, seemed to threaten the occlusion of much of the British work (recall both the perception of the heavy water work as a longer-term endeavour and the consensus that Britain had not the industrial capacity to pursue the work alone).

For Akers, then, 1943 began as 1942 had ended, with efforts to improve relations with Groves and Conant. Akers' chief objective was to establish whether the Americans' increasingly unco-operative attitude really was based only on a desire for secrecy, or whether an ulterior motive might be present. He was beginning to fear the latter: 'it certainly begins to look as if there is, in the background, a desire to build up a monopoly in this field for the USA…. I am really getting very worried at the interminable delay in settling anything'.[4] Groves, however, continued to assure him that secrecy was the Americans' only real object. On 2nd January, Akers received a telephone call from Conant, who sought to assure him that most of the outstanding

[2] Akers and Halban, 'Note on relations between the British, Anglo-Canadian and American groups', 22nd January 1943, AB 1/128 (TNA)
[3] Akers & Halban, 22nd January 1943, AB 1/128 (TNA)
[4] Akers to Halban, 1st January 1943, AB 1/374 (TNA)

questions around co-operation could be easily resolved; only the slightly more complex question of heavy water work presented any real difficulty. Conant also reiterated that 'the only reason for their wish to confine exchange of information… is for secrecy'.[5] This doubtful assurance gave Akers his opening:

> I deliberately put forward the idea that we might, in Canada, review proposals not to proceed to large scale work, if the Americans could not see their way to a proper co-operative development in the U.S.A. If secrecy is their sole reason for their general attitude of exchange of information, then it is difficult to see why they can object to our proceeding to large scale development in Canada.[6]

This was little more than a threat, utterly reflexive and perhaps impelled by frustration more than considered thought, to elevate the Canadian project as a response to (and in defiance of) American antipathy. To Akers, the Americans seemed increasingly to be advancing an argument that was very nearly tautologous. It seemed illogical, fallacious, to argue that transfers of information could be made 'only when the receiving party can make use of it', if such judgements lay in the hands of Americans whose assessment was already that Britain could not – could never – make use of the information. Groves and Conant were, in effect, threatening to lay down restrictions arising from the premiss that the British could not (and thus should not) hope to contribute to the project as equals. Very well: the British would respond, not in kind, but in proportion, highlighting the Americans' own illogic to them. If the Americans were to beg the question, the British would engage with the resulting restrictions in such a way as to short-circuit the Americans' circular reasoning. Canada and the Canadian project thus became, if only momentarily, a rhetorical weapon, a tool not quite of coercion but certainly of leverage *vis-à-vis* the Americans. This impulsive idea of elevating the Canadian project was one to which the British would shortly return more seriously.

In the meantime, what had emerged most clearly for Akers was a sense of frustration. He had little sympathy for American appeals to precedent: an attempt by Bush to draw parallels with a particular radar project on which the British had withheld information from the Americans was quickly dismissed as a false analogy, Akers' sardonic phrasing betraying some of his irritation: 'I doubt if even they will maintain with conviction that the tube alloy project is an American invention in which the British are not interested'.[7] That same sardonic attitude was applied to a scheme of Groves', of which Akers had just been informed, for the sequestering of the leading American physicists in a secure and remote location: when Groves acknowledged that it might not be wise to fully isolate the ten best physicists, Akers asked whether putting apart the ten worst physicists might secure the same 'cynical pretense at secrecy'.[8] Beneath such flippancy lay a real concern that a policy of isolation might put key fast neutron physicists beyond interaction with Chadwick, Peierls and their other British counterparts – a loss of collaboration which would, in the British conception of things, be to the detriment of both programmes.

The year had clearly not begun well. Akers found himself trapped in the labyrinth of American obfuscation, frustrated by the circularity of the debate, torn between the vanishing hope that their issues arose only from

[5] Akers to Perrin, 2nd January 1943, AB 1/374 (TNA)
[6] Ibid.
[7] Ibid.
[8] Ibid.

miscommunication and the rising fear that it there might instead be some unforeseen mendacity underpinning the Americans' latest policy.

The presenting issue was the Canadian slow neutron work. The Canadian project's dependency on American goodwill around the provision of heavy water had been noted by Mackenzie the previous October, but American reassurances then had been sufficiently strong that nobody other than Mackenzie seemed unduly concerned,[9] and Mackenzie himself was soon after told by Conant that there was 'no danger on that score'.[10] Yet difficulties *did* emerge soon after, both with the supply of heavy water and with collaboration more generally. Mackenzie had written formally to the Americans requesting an allocation of heavy water for Halban's team, and Akers had delivered the letter.[11] By mid-December the request had still not been met. Worse, the Americans were pursuing similar research work at Chicago, and were increasingly reluctant to share information about it with the British.[12] This placed the British in a difficult position, for if this situation reflected the new American policy the entire basis for the Montreal project now seemed invalid. [13] Arguing for a return to the original understanding was unlikely to succeed, so little recourse was left to Akers but to attempt to reconcile the Americans to a trilateral programme, reconfiguring the work at Montreal to complement the Chicago work, and vice-versa. The proposal was that chemical work resulting from the heavy water reactors would be treated as a joint Chicago-Montreal endeavour, with the majority of the physics work meanwhile being done in Canada; engineers from the Canadian team would then join the American design firm to work on the pilot and full-scale piles. Naïvely, it was suggested that the transfer of personnel from the Canadian outfit into the US-based engineering teams – a proposal of which the Americans had always been chary – would present no 'political' difficulty 'because the engineers in Dr. Halban's group will be British or Canadian born'.[14] The penny had yet to drop that it was precisely this with which the Americans took issue.

Worse lay ahead. Mackenzie, too, had received a telephone call from Conant on 2nd January. Its import, however, was somewhat different. Conant told Mackenzie that he was 'sending… a letter which might sound more harsh than was really intended'.[15] This letter set out to answer the earlier query from the Canadians about the assignment of heavy water produced at Trail which the Canadians had requested a share of on behalf of the project at Montreal. Conant reported that he was 'now in a position to give a definite answer'. By way of explanation, and to excuse his delay in responding, Conant began by elaborating two key changes to the American organisation. The first was the recently taken decision 'to supplement the Chicago program by an intensive effort using heavy water in the production of element "49"' – which 'greatly modifies the basis of our previous discussion'. The second change was an order which, Conant claimed, he and Bush had 'received from the top', to

[9] 'I thought the crucial point was arrangements for heavy water; no one else took this seriously'. CJM diary, 27th October 1942
[10] CJM diary, 28th November 1942
[11] Akers to Perrin, 9th November 1942, AB 1/87 (TNA)
[12] *cf.* Akers & Halban, 22nd January 1943, AB 1/128 (TNA)
[13] Akers to Conant, 15th December 1942, AB 1/128 (TNA)
[14] Ibid.
[15] CJM diary, 2nd January 1943

> [restrict] our interchange on this whole subject by the application of the principle that we are to have complete interchange on design and construction of new weapons and equipment only if the recipient of the information is in a position to take advantage of it in this war. Such a principle is, of course, in the interest of secrecy.[16]

Since neither Canada nor Britain would be in a position to produce elements '94' or '25' for the war, there could be no interchange with them on the subject. Interchange on diffusion would, however, be allowed to continue, for here the British had made good progress. This, then, was Conant's answer. Canada would receive some (limited) supplies of heavy water, but nothing more. No additional information would be forthcoming. The Montreal project, which had been embarked upon with the Americans' blessing, in the expectation of their support, had, in effect, been cut adrift. The nebulous policy of restriction against which Akers had already been arguing had now become concrete in an almost gratuitously extreme form. Conant then outlined the future he envisaged for the Canadian programme:

> We should very much like to have the group of scientists assembled in Canada carry on the fundamental scientific work for the use of heavy water so that DuPont Company could base their designs on this experience.... We should expect that this Canadian group would direct the program along lines worked out in connection with the American engineers… and make all their results available to this designing group[17]

This was justified in the language of joint endeavour – the mutual aim of producing a weapon for use against the common enemy as rapidly as possible – but the effect would be simple subservience: the team at Montreal would work to American instruction, with information flowing only in one direction. Far from sounding 'more harsh than was really intended', Conant had unilaterally imposed an almost complete stoppage upon the British programme as it had been jointly conceived only a few months previously. The British were dumbfounded, as much as anything by the illogic and perceived unfairness of the policy. There was an infuriating circularity in the Americans' new stance: no co-operation would be given in any field in which the British were unlikely to make a significant wartime contribution; and the British were unlikely to make a significant wartime contribution without co-operation. By insisting on an arbitrary metric, shaped by a variable under their control, the Americans were very nearly in a position simply to dictate terms. Such, certainly, was the tone Conant had adopted in his letter to Mackenzie.[18]

The significance of Conant having informed the Canadians first, rather than the British, is difficult to weigh. The simplest explanation, that the letter from Conant was the natural consequence of a query originating in Canada and was therefore an item of business which could be handled on a purely bilateral basis, has merit only insofar as it can be argued that the Americans had not appreciated the wider ramifications of their drive to secrecy. Yet this can hardly have been the case: the appeals to high policy (these were ostensibly orders 'from the top') and the articulation of general points of principle on interchange betokened a thorough understanding (much though it may have been denied) of what the Conant letter would mean for

[16] Conant to Mackenzie, 2nd January 1943, AB 1/87 (TNA); emphasis in original
[17] Ibid.
[18] Ibid.

Canadian and British involvement in the American project. More Machiavellian interpretations of the American approach are possible. One is that the heavy water issue was seized on by Conant *et al* as the most convenient method for introducing a new, restrictive policy on interchange whilst retaining the semblance of ordinary procedure. There is also the possibility that Mackenzie was consciously chosen as the first recipient of the news, either as part of an active effort to force divisions between the British and Canadian programmes (and thus to secure Canadian acquiescence in useful fields without the burden of British involvement), or more passively to treat the two parties as sovereign entities, as indeed they were. The truth almost certainly lies somewhere between these interpretations. It is clear that the new policy had been in gestation for a long while, and that hints of what would be outlined as American policy had already been given to Akers; it is equally clear that the Americans were not especially grieved to learn of fractures between the British and Canadians over the future of the project.

At any rate the British were swiftly apprised of the unwelcome new policy. The British attended crisis meetings with their Canadian counterparts at the NRC on the 7th January, at which Akers was seen to be 'much disturbed'.[19] The motive for the Americans' position was a mystery. Why had they adopted such an unco-operative attitude? The tone of the letter seemed so at odds with the previous warmth of nuclear-scientific relations that it was hard to believe that the American scientists actually endorsed its contents.[20] This was deliberate. Conant conveyed, or at the very least allowed the British to alight on, the narrative of a military take-over to which the scientists were reluctantly acceding, but this seems to have been largely for convenience's sake. There is little to suggest that Conant's conscience was greatly troubled by the new approach. MacDonald was on surer ground in considering that the new policy 'may also be evidence of a desire to keep the fruits of these developments as far as possible in American hands, both in the military and industrial field.'[21]

The shock elicited by the Conant letter did not dissipate, but was instead compounded on 13th January when the British, in the person of Akers, were handed an American memorandum on the subject of interchange, which made explicit the implications of the new policy for each aspect of nuclear research.[22] This document, although dated after Conant's letter to Mackenzie (7th versus 2nd January) was assumed by the British to represent the ur-text for the American's new collaboration policy. This certainly seems to have been the Americans' intent, for the structure and phrasing of the memorandum are such as to convey the sense of an absolute prescriptive policy. At any rate, from this date onwards the two would be conflated, the letter and the memorandum each being significant enough to earn the definite article in British correspondence. In the weeks and months ahead exasperated or despairing references to 'the Conant memorandum' or 'Conant's letter', used more or less interchangeably, would litter British cables.

For all the tension it precipitated in Anglo-American nuclear relations, the Conant memorandum has been consistently down-played in American accounts. The American official historians Hewlett and Anderson gave a defence of the Americans' behaviour in this respect, arguing that the memorandum was 'only a

[19] CJM Diary, 7th January 1943
[20] MacDonald to Anderson, 8th January 1943, AB 1/374 (TNA)
[21] Ibid.
[22] Akers to Munro, 14th January 1943, AB 1/374 (TNA)

working paper', and that it was never officially presented to the British.[23] This is incorrect. As Akers' account makes clear, the British *did* receive a physical copy, from Conant and Bush, on 13th January – and such an argument at any rate seems rather to miss the point.[24] The entire course of communication between the US and their British and Canadian counterparts in January 1943 was predicated on an American policy of extremely limited exchange and the implicit (and occasionally explicit) assumption that the American programme was the superior: a rupture in relations, or at the very least a substantial reconfiguration, was exactly what the Americans were seeking.

The Conant restrictions, though they can be seen in retrospect to have been prefigured in the struggles of late 1942, had taken the British by surprise. The Anglo-Canadian slow neutron project was expressly founded on the idea – in British eyes, the promise – of collaboration with the Americans. There had been multiple verbal assurances of a division of labour, the Chicago team working on graphite, the Montreal team on heavy water. That these principles no longer stood required explanation. The British became fixated, for a time, on one hypothesis, hinted at by Bush: that US reluctance to collaborate with the British might have to do with an agreement the British had made for general scientific collaboration with the Russians. Bush, however, would not be drawn on the details of the Americans' objection to the agreement,[25] and it was difficult for the British to see why the Americans could imagine the agreement applying to the nuclear realm. To establish this took many weeks, however,[26] and even after the Russian theory had been discredited, the British were willing to clutch at similar explanatory straws. As late as April, Akers was willing to seize upon a theory of a more general American reticence around co-operation, encompassing other fields than the nuclear.[27] Likewise, in May, Oliphant noted a rumour that the Americans' real interest was commercial.[28] What the British were slow to realise is that the Americans had little interest in actually enumerating their reasons for restriction, precisely because this would enable the British then to address them. The hint of displeasure with the Russian agreement, as with the broader principle of compartmentalisation and references to orders from on high, served the convenient function of an excuse.[29]

The British envisaged, almost instinctively, a number of responses: to seek, through Mackenzie's good offices, to establish from Conant the real cause of the difficulty, if possible to remedy it immediately, and if necessary to appeal to higher authorities in the United States.[30] Akers meanwhile began to hold back from further meetings with Conant, in favour of consultations in Canada, including with Howe and Mackenzie,[31] for there was the question of Anglo-Canadian policy to address. Whether or not the Americans had intended to drive a wedge between the two parties through their gradated breaking of the news, the British perceived a need on their own part both to ensure unity of policy, and then to make that unity evident to the Americans. The ideal manifestation of that spirit of Commonwealth indivisibility would be for the Canadians themselves to make strong representations on Britain's account. A file in the UK National archive contains

[23] Hewlett and Anderson, *The New World*, p.268
[24] *cf.* Akers to Perrin, 15th January 1943, AB 1/374; Akers to Munro, 14th January 1943, AB 1/374 (TNA)
[25] Akers to MacDonald, 18th January 1943, AB 1/374 (TNA)
[26] Akers to Wolfenden (BCSO), 25th February 1943, AB 1/374 (TNA); MacDonald to Anderson, 27th February 1943, AB 1/374 (TNA)
[27] Akers to Gorell Barnes, 27th April 1943, AB 1/374 (TNA)
[28] Peierls to Akers, 25th May 1943, AB 1/374 (TNA)
[29] Vincent C. Jones, *Manhattan: The Army and the Atomic Bomb (United States Army in World War II: Special Studies)* (Washington DC: Center of Military History, United States Army, 1985), pp.150-151, 271
[30] MacDonald to Anderson, 8th January 1943, AB 1/374 (TNA)
[31] Akers to Perrin, 21st January 1943, AB 1/374 (TNA)

a draft letter to Conant, in Mackenzie's name, which argues strongly against the restrictive policy outlined in the Conant letter. Taking issue first with the policy's inefficiency, then its inequity, the letter culminated in a strident defence, from a Canadian perspective, of the Montreal work as an earnest large-scale joint endeavour:

> From the beginning of our discussions with [the British regarding] the moving of their team and its enlargement here into an Anglo-Canadian group we have always had in mind that the organisation would be a complete one capable of tackling all parts of the project up to the point of completion of designs for a full-scale plant…

From this flowed a threat echoing that which Akers had earlier levelled at Conant, to forge on regardless. If the Americans persisted in excluding the British, 'we will have to revert to our original plan of proceeding to Pilot plant erection and full-scale plant design'.[32]

At face value, the letter would thus seem to imply that the Canadians were fully aligned with the British, each state resolved on a joint effort to develop a full nuclear programme, each preferring to resist the Conant proposals, at the risk of a full breach, than meekly to accept their strictures. This, however, would be the wrong conclusion to draw from the document, for not only was the letter not sent: it was also not written by Mackenzie. Mackenzie's diary entry for the crisis meetings of 7th January states that 'They [that is, the Britons present] wanted me to sign a letter drafted by Akers. I refused; said that we should go down to see Conant and try to discover the real difficulties'.[33] It therefore seems clear that the unsent letter, for all its elliptical phrasing and adoption of a Canadian perspective, was of British authorship, and reflected little more than an opportunistic and perhaps slightly crude British effort to conscript the Canadians.[34] Mackenzie's flat refusal meant the effort was stillborn. His reluctance to present a facade of Anglo-Canadian unity likely stemmed in part from justifiable pique at the idea that he might meekly submit to British direction – and certainly Akers never again sought so directly to steer Canadian policy – but would also appear to reflect a genuine difference of interpretation. Mackenzie was, after all, personally far closer to Conant than any of his British counterparts, and had had the American perspective preached more strongly to him in the preceding weeks. He was probably therefore sincere in recording his sense of being 'not so sure' that the Conant proposal was unreasonably imbalanced.[35]

The significance of this episode should not be overstated. The British were generally sensitive to Mackenzie's perspective, and whilst fissures would eventually emerge between the British and Canadian nuclear projects this incident was not their origin. At worst the incident appears to have contributed to a slight chill in relations between Akers and Mackenzie (though other frustrations arising from Mackenzie's attitudes and working practices also played their part).[36] The British had received a salutary reminder of the need for tact in their handling of the nuclear relationship with Canada, and indeed by the end of January,

[32] Draft response to Conant, January 1943, AB 1/374 (TNA)
[33] CJM Diary, 7th January 1943
[34] Draft response to Conant, January 1943, AB 1/374 (TNA)
[35] CJM diary, 7th January 1943
[36] cf. Akers to Munro, 30th January 1943, AB 1/374 (TNA)

when the British began producing papers outlining their considered response, Akers was at pains to ensure that Mackenzie was included in the correspondence and thereby apprised of the latest British thinking.[37] From the perspective of this thesis, however, the incident provides an interesting first indication that Canadian perspectives on the relationship with the United States might differ from the British, in ways the British might not have foreseen.

Deprived of the comfort of a simple solution, the British were forced to acknowledge that there were deeper issues at play, requiring deeper thought than they had hitherto exercised. Yet forming a coherent response to the Conant proposals would take time, and time was one of the many commodities the British lacked relative to the Americans. From January onwards, the British found themselves engaged in an iterative process of internal and external negotiation, sounding out the Americans on various scenarios and reconceptualising the Tube Alloys programme in light of their responses. As time passed unfruitfully it became clearer and clearer that the American proposals, although not non-negotiable *per se*, certainly represented a very firm statement of intent. The situation had become astonishingly bleak for the British. It was hard to see what future there could be for the Montreal project, which had looked such a promising venture only a few months earlier. The Canadian historian Donald Avery presents an extreme assessment of the Conant restrictions' endpoint: 'The answer was obvious: the Montreal Laboratory had a limited future, and the NRC should be given the opportunity to cut its losses'.[38] This goes slightly too far: as Conant's correspondence with Mackenzie indicates, the Americans were not averse to the idea that the Montreal Laboratory might muddle on as a sort of junior adjunct to the American project, conducting basic research in support of the engineering design work. But it was nevertheless true that much of what the British had feared six months earlier – the dwindling of their leverage *vis-à-vis* the American programme, the loss of access to the best of allied physicists' thinking – had come to pass. The effort to leverage participation through Montreal seemed therefore to have failed. The British were consequently driven to ask increasingly fundamental questions about their own intentions. What was the end to which the negotiations were being carried out? Was this now simply a salvage operation? If so, what was to be salvaged? Was it the collaboration with the Americans, or the project in Canada, or the linkage between the two? What mattered most? The process by which the UK answered these questions shaped, and was shaped by, the participation of Canada as a third nuclear actor.

Articulating a Response

The extent to which the British were taken aback by the Conant proposals has already been noted. It had initially been assumed that the army take-over had prompted the review of American interchange policy, but in the wake of the Conant letter and memorandum Akers was less and less willing to allow the American scientists the benefit of the doubt. He was personally frustrated with Bush and Conant, neither of whom he thought understood, or had time to address, the complexities of the nuclear project.[39] Nor was there much

[37] Akers to Munro, 30th January 1943, AB 1/374 (TNA)
[38] Avery, *The Science of War*, p.186
[39] Akers to Munro, 14th January 1943, AB 1/374 (TNA)

hope that Groves' growing hold over the project would ultimately lead to any improvement.[40] The Army may not have borne all the blame, but their attitude was still far from friendly. Moreover, so long as it was unclear who held the ultimate authority, the scientific and military components of the American programme could each continue to blame unpopular policies on the other.[41] Efforts to resolve this tension by meeting with both sides simultaneously bore little fruit, however, for there was too much unity in the American ranks. Meanwhile, further troubling signs were detected. On 18th January Akers reported on the Americans' intention, already intimated but now confirmed, fully to isolate (that is, physically as well as organisationally) their theoretical physics group. The Americans expressed a hope that Chadwick and Peierls would be sent out for discussions with the American group before this took place, since no contact would be possible afterwards ('no information to pass out from American Group but British could send in written memoranda on British work', *i.e.* information would pass in only one direction).[42] Akers again found himself highlighting the obvious issue: 'apart from any political aspect this procedure is in our view entirely inefficient'.[43]

The view from London was equally pessimistic. Anderson seems to have viewed the crisis almost despairingly in the first instance, describing it as potentially the last stage in the joint life of the projects: a 'final effort' was called for, to win over the Americans to the idea that full collaboration would be to the benefit of both countries.[44] (Note the reference to 'both countries': Anderson at this stage seems to have been content to perceive this as a bilateral rather than trilateral issue, with the Canadians arrayed squarely behind the British). A swift review of past commitments by the Americans buoyed him slightly, however, and there was always a fallback option: Churchill could yet be brought in to tackle the issue directly with Roosevelt.[45] The momentary comfort which Anderson *et al* took from revisiting the 1941 correspondence is, in a sense, indicative of the flaw in the UK's nuclear diplomacy at this point. Whether they realised it or not, the British were stuck in a 1941 mind-set, increasingly ignorant of the realities of American dominance of the atomic enterprise and still somewhat naïve in their treatment of Canada as a conveniently located and implicitly acquiescent territory, rather than as a partner in any right of her own. It was, in fact, the crisis precipitated by the Conant letters which ultimately drove the Tube Alloys bureaucracy to reconfigure its attitude towards (or perhaps more accurately, understanding of) the true position, which was, indeed, increasingly tripartite.

The hope which Anderson had expressed of a swift high-level resolution to the impasse was briefly kindled when Churchill and Roosevelt met at Casablanca in the second half of January. Word came to Canada on 23rd January – where Akers and his colleagues were working feverishly to comprehend what had gone wrong, and to construct convincing arguments for a restoration of collaboration – that the two leaders had agreed upon '100% co-operation'.[46] Mackenzie, ever the pessimist, doubted it would make any difference. He proved correct, in a sense, for this was the first of several such false dawns: it soon emerged that no

[40] Ibid.
[41] Ibid.
[42] Akers to Perrin, 18th January 1943, AB 1/374 (TNA)
[43] Ibid.
[44] Draft telegram, Anderson to Macdonald, 12th Jan 1943, AB 1/374 (TNA)
[45] Anderson to MacDonald, 12th January 1943, AB 1/374 (TNA)
[46] CJM diary, 23rd January 1943

such agreement had actually been reached. Gowing doubted the subject was even discussed between the two leaders.[47] Yet throughout the spring of 1943 the British would experience a fresh wave of optimism each time there was contact between the two men.[48] The evident lack of any Prime Ministerial *deus ex machina* in these months condemned the British to a period of introspection, of drafting and redrafting position papers summarising what had gone wrong and how, possibly, things might eventually be put right. (The British were prone to such bouts of self-flagellation in their wartime relationship with the United States: there was often little else that could be done). The Montreal Laboratory meanwhile lay almost dormant, and the gulf between British and American research continued to widen. As time passed the need to articulate a coherent strategy for establishing acceptable collaboration with the Americans, already rather urgent, thus became existentially important. What was abundantly clear, even in the depths of post-Conant-letter despair, was that the United Kingdom would never give up entirely on nuclear work; if this was what the Americans hoped to achieve, it might be best to disabuse them of the notion as soon as possible. Halban, writing in February, suggested as much: 'Surely we should convince United States that British Commonwealth would not give up source of military and economic power, even if work is slowed down by lack of exchanges and of material'.[49] (Halban's invocation of the Commonwealth here might appear somewhat remarkable, given his French citizenship and cosmopolitan European descent,[50] but such remarks nevertheless appear typical of his character: his official letters throughout the period 1941 – 1945 convey only a wholehearted identification with Britain and the interests of the British Commonwealth. One might suggest that Halban, as somewhat of an outsider, had made explicit a conflation which Britons generally left unspoken).

There were limits, too, to the methods by which the British could seek to influence American opinion. Perhaps a more granular, case-by-case approach might work. There was a chance of salvaging collaboration on heavy water and the slow neutron work, if the British and Canadians could demonstrate the appropriate financial and political resolve. Hopes of access to information on electromagnetic separation would probably have to be sacrificed, since there was no real likelihood of the British entering the field any time soon. The most urgently required action, though, was on the fast neutron work, including the crucial ordnance question. The Americans' plan to isolate the theoreticians could not be allowed to stand, for 'In many ways this proposal seems the most foolish and dangerous of all'.[51] There seemed to be consensus within the Anglo-Canadian project as to the moral and practical impossibility of withholding information from the Americans as a mere negotiating tactic:

> Unless we are prepared to build a large scale plant to make element[s] 25 or 49, either in Britain or Canada, it would seem wrong to [withhold] our information, however distasteful the conditions, as presumably this must delay the completion of a plant by the Americans, and so increase the risk that Germany may have this weapon first.[52]

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[47] Gowing, *Britain and Atomic Energy*, p.159
[48] *cf.* Perrin to TA Technical Committee, 27th January 1943, AB 1/374; Anderson to MacDonald, 27th February 1943, AB 1/374 (TNA)
[49] Halban to Akers, 13th February 1943, AB 1/374 (TNA)
[50] Halban was born in Leipzig, to Austrian parents; his father was of Polish-Jewish descent; Halban himself had lived and worked in Zurich and Copenhagen before moving to France.
[51] Akers & Halban, 22nd January 1943, AB 1/128 (TNA)
[52] Ibid.

Two broad schools of thought emerged. One argued that Britain should adopt a confrontational line, resisting as forcefully as possible the strictures the Americans sought to impose. A high-level diplomatic campaign should be waged to convince the Americans to relent, with a wholly independent Anglo-Canadian programme as the explicit fall-back position should that effort fail. The other school argued for acceptance of the Americans' terms as having the better prospect of securing some measure of participation in the American programme in the medium-term. Their suggestion was that Britain should acquiesce, adopting an approach of reluctant but demonstrably thorough compliance with the Americans' strictures in the hope of their eventual loosening, and for the sake of retaining the moral high-ground.

There was outwardly much to recommend a policy of resistance. On 19th January Perrin, who along with many of those based in the London Tube Alloys office favoured the policy, shared his views with Akers, whose experience in America had inclined him more towards acceptance of the Conant restrictions. Perrin's instinct was easily summarised:

> American regulations are clearly unwelcome and will lead to inefficient working. Attitude here is that every effort up to highest level should be made to change regulations and if these fail serious consideration would have to be given to stopping all information from here and continuing on our own. [53]

This was to be an increasingly popular stance. Chadwick, Simon and Peierls were all reportedly of the view that, for the time being at least, the transmission of British progress reports to the US should cease.[54] Chadwick had also made clear that he would be unwilling to make a previously proposed trip to meet with the US theoretical group. Prompted by Peierls' queries as to what should be done with his latest batch of reports, which ordinarily would be forwarded to the Americans, Perrin mulled the statement that could be made by withholding them completely from the Americans, and on other possible forms of escalation:

> Over here we feel that the American proposals must be resisted as strongly as possible and that if the technical arguments which we can produce are not accepted the matter must be taken to the level of the Prime minister and the President. [55]

Advocates of confrontation recognised that an overly assertive British response might impede overall progress towards the bomb. Allowing this, though, could not alter the fact that American intransigence must equally have a delaying effect. If the greatest imperative was the securing of a working bomb by an allied power in as short a timeframe as possible, full collaboration must surely be the best route.[56] It was galling to think that the Americans could put aside that principle, for seemingly entirely selfish reasons, whilst at the same time expecting the British to accept it as a moral absolute, but little else could be done. The only other hope – forlorn as it already seemed – was that the gesture of '[endeavouring] to get all possible information from here to the States as quickly as possible' might somehow secure effective co-

[53] Perrin to Secretary BCSO, 19th January 1943, AB 1/374 (TNA)
[54] Ibid.
[55] Perrin to Gorell Barnes, 19th January 1943, AB 1/374 (TNA)
[56] Perrin to Secretary BCSO, 19th January 1943, AB 1/374 (TNA)

operation, whether through goodwill, demonstration of utility, or moral shaming.[57] Yet beneath all these wranglings about suffering for the greater good, there was always the sense that there might be a more palatable alternative available, could they only alight upon it. Perrin reported his view that

> If our relations with Americans on T.A. [Tube Alloys] project as a whole do not improve or actually worsen I believe consideration should be given to best use of joint British and Canadian resources whether for T.A. (1) or T.A. (2) projects[58]

– a euphemistic way of suggesting that the British should return to the drawing board and design a unified Anglo-Canadian programme for nuclear research without any American involvement whatsoever. This position clearly had some appeal. Peierls, not ordinarily impetuous on questions of high policy, saw wisdom in the laying of contingency plans for working without the Americans: 'An insurance premium is not usually considered wasted if the house does not catch fire!'[59] Even Akers, who had advanced the most forceful arguments for accepting the Americans' position, at times found himself drawn back to the threat/gambit of a redoubled Anglo-Canadian effort in Canada, having at one stage begun discussions with personnel there – including representatives from Canadian industry – on the feasibility of pilot plant construction in the near future, the hope, as ever, being that when the Americans learnt of this resolve they would relent and permit relevant exchanges. Yet always there was the nagging doubt – could it be done? – and the accompanying fear that separation from the American programme would mean falling irrecoverably far behind the cutting edge of nuclear research.

The only argument against this position that Perrin and the advocates of confrontation could conceive of was that of moral obligation to the allied war effort.[60] This, though, was exactly what Akers seemed to be suggesting: the idea that Britain should humbly submit to whatever course would be of 'maximum benefit' to the United Nations' war effort.[61] For all his earlier willingness to warn the Americans of British willingness to plough an independent nuclear furrow, Akers had become the exemplar of the 'acceptance' party. Acquiescence, he argued, was 'the right course to follow', for in maintaining at least the semblance of collaboration with the United States Britain would 'appear to lose no advantage which could be obtained by severing relations'.[62] The hope ultimately was that the Americans would be won round by the practical demonstration of the benefits of collaboration and by the moral example of British devotion to the common cause:

> I believe that our best chance of convincing Americans of advantages of complete interchange is to get this working wherever there is a definite request for it to be done, from their side, by people who can assert that, without such exchange, quickest realisation of full-scale plants will be jeopardised…. the useful object of such exchange is to give the Americans our latest ideas to enable them to complete their plant as quickly as possible[63]

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[57] Perrin to Gorell Barnes, 19th January 1943, AB 1/374 (TNA)
[58] Perrin to Secretary BCSO, 19th January 1943, AB 1/374 (TNA)
[59] Peierls to Akers, 1st May 1943, AB 1/374 (TNA)
[60] Perrin to Akers (via Secretary BCSO), 19th January 1943, AB 1/374 (TNA); 'Tube Alloy Project. Summary and Observations on General Policy', 19th April 1943, AB 1/374 (TNA); Perrin to Gorell Barnes, 19th January 1943, AB 1/374 (TNA)
[61] Perrin to Gorell Barnes, 19th January 1943, AB 1/374 (TNA)
[62] Akers to Mackenzie, 30th January 1943, AB 1/374 (TNA)
[63] Akers to Perrin, 21st January 1943, AB 1/374 (TNA)

This was the crux of the case for acceptance. The Americans had manoeuvred the British into an uncomfortable position, creating an irresolvable tension between the objectives of the United Nations on the one hand and the pursuit of British self-interest on the other. That there might be a moral inconsistency in all this appears not to have troubled the Americans overmuch.

What of the Canadian position? This was at once simpler than the British, and more complex: simpler, in that only the Montreal project was directly in view, and more complex, in that relations with the state's two most important partners were involved. Clearly there was an appetite amongst the Canadians for a resolution of the impasse. They too were experiencing intense frustration, less from the effective suspension of the work at Montreal, galling though that was, but rather with Canada's powerlessness to resolve the conflict between her two more senior partners. Canada was caught in the crossfire, too minor a power to be able to effect a reconciliation whilst simultaneously significant enough to be materially impacted by the stalemate. It was the worst of both worlds, and there was truth in an increasing intuition of Halban's that a more prominent role for the Canadians – for Mackenzie himself – might help resolve the political differences. Howe had apparently felt, as early as mid-January, that 'if they left the negotiations to us, it would be more satisfactory'.[64] To this end, Mackenzie had offered to see Conant, 'who would probably speak more freely to a Canadian than to an Englishman'.[65]

Gowing's account of this period of acute awkwardness in Anglo-American nuclear relations introduced the idea of an opposition between the feeling at Montreal that 'almost anything was preferable to their own idleness' and the feeling in London that 'anything was preferable to accepting the intolerable American terms for collaboration'.[66] The archival record would seem to confirm her supposition that this was a distinction driven not by nationality, but by location and work programme. The distinction was not absolute – the independent option was countenanced at one stage or other by many of the key figures in Montreal and Ottawa – but there was nevertheless an emergent sense that perspectives on the Conant crisis night vary depending on the side of the Atlantic one viewed it from.

The Path to Quebec

The British continued to vacillate between resistance and acceptance, and even after the disappointment at Casablanca (see above, p.79) there was a lingering hope that high level talks might break the stalemate. (Note, however, that Mackenzie King's intercession was never sought; the highest active representative of the Canadian government was Howe, whose indisposition at crucial moments in practice left Mackenzie as senior Canadian. Even where the Montreal Laboratory was concerned, advocates of a top-level diplomatic effort conceived it as an issue to be solved bilaterally.) The main hope now lay in the fact that Churchill had entered into a dialogue with Roosevelt's close advisor, Harry Hopkins, who assured the by now

[64] CJM diary, 15th January 1943
[65] Akers and Halban, 'Note on relations between the British, Anglo-Canadian and American groups', 22nd January 1943, AB 1/128 (TNA)
[66] Gowing, *Britain and Atomic Energy*, p.158

somewhat jaded British of his best endeavours.[67] Since the Prime Minister was known to be in correspondence with Hopkins – perhaps, at last, on the cusp of a resolution – other contacts ought therefore to be minimised.[68]

It was at this moment that Halban received an invitation to a meeting in New York on the topic of slow neutron interactions. The invitation, delivered to Mackenzie by Conant, was seen optimistically by the former as possibly indicating 'a softening of the American attitude regarding co-operation with us'.[69] This presented something of a quandary: should Halban be permitted to go, as evidence of British goodwill and as a tangible reminder of the potential value of the Anglo-Canadian programme, or should his participation be forbidden, by way of sanction and in recognition of the disturbed state of Anglo-American nuclear relations? In short, should acceptance or confrontation prevail?

The matter was debated at length on both sides of the Atlantic – though not by Mackenzie, away in western Canada, who was unable to participate. Halban strongly opposed the idea that he should be prevented from going, and particularly abhorred a suggestion (not ultimately enacted) that he plead illness as his excuse, but was over-ruled. The final decision was made by Anderson, in London, who felt it best not to weaken the Prime Minister's negotiating position by allowing Halban to pool information unreciprocally with the Americans. The consequences were soon felt. Mackenzie took the news poorly, and in subsequent correspondence with Conant sought to distance himself and the NRC from the decision, which he blamed squarely and unsympathetically on the British.[70] The Americans meanwhile had perceived a slight in Halban's non-attendance, and began to increase their pressure on the British. Conant's correspondence to Mackenzie hinted at the adoption of a yet-harder line,[71] and made a second demand for a visit from Halban.[72] Anderson saw this as a conscious effort to engineer a breach between Britain and Canada.[73] Whether or not that was Conant's intention, the effect was certainly to emphasise to Mackenzie the cleavages between his own perspective and that prevailing in London. Halban, too, had sensed the divergence, recording his impression that 'our whole work could progress better if the Canadian Government were invited to take a bigger share of responsibility for meeting the political difficulties'.[74]

The case for resistance had always assumed that the United Kingdom would ramp up its preparations for an independent programme, but it was never fully apparent whether this was to be by way of insurance or as leverage. The latter assumption had had its proponents in previous months, but the experience with Halban had been somewhat chastening. To actively separate from the Americans would be an extreme step, and since there remained a glimmer of hope in the discussions Anderson shied away from it. Increasingly detailed consideration was, however, given to the question of what *could* be done, at Montreal and in Britain, in the complete absence of American assistance. Halban and the Montreal team prepared

[67] Anderson to MacDonald, 24th February 1943, AB 1/374 (TNA); Perrin to Akers, 28th June 1943, AB 1/374 (TNA)
[68] Anderson to MacDonald, 1st March 1943, AB 1/374 (TNA)
[69] MacDonald to Anderson, 27th February 1943, AB 1/374 (TNA)
[70] Mackenzie to Conant, 17th March 1943, and *cf.* Mackenzie to Conant, 30th March 1943, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[71] Conant to Mackenzie, 24th March 1943, AB 1/374 (TNA)
[72] MacDonald to Anderson, 14th March 1943, AB 1/374 (TNA)
[73] Anderson to MacDonald, 26th March 1943, AB 1/374 (TNA)
[74] Halban to Akers, 25th March 1943, AB 1/374 (TNA)

programmes for each of the divisions, complemented by reports on the theoretical and chemical work already performed. These had all been produced in an atmosphere of extreme uncertainty, and morale was correspondingly low: 'You may imagine that we were rather depressed', Halban wrote, to learn of the poor progress of the negotiations.[75] For the project to continue without American participation was so manifestly sub-optimal that to have to begin to plan for it was profoundly dispiriting. Yet there was still plenty of work ongoing, plenty upon which to build, in Britain as well as in Canada. British technical stock *vis-à-vis* the Americans was declining fast, but there were still capable teams at Birmingham working on theoretical physics (under Peierls) and chemistry (under Haworth), along with various sub-teams at Cambridge, Liverpool and Manchester under the direction of Chadwick, and at Oxford under Simon. Important measurements were being take at the National Physical Laboratory and the Government Chemistry Laboratory. British industry had also been drawn in: ICI, through various subsidiaries,[76] had been involved from the start, but so too now were Mond Nickel, working on metallurgy. Across the UK, there were approximately 70 academic researchers at work, and another 100 or so in industrial establishments (more, if tangential work at Metropolitan Vickers was included). Nineteen of the university researchers were of professorial calibre. (The full complement at Montreal, meanwhile, was far smaller: approximately 36 scientists and engineers were present, of whom only around two-thirds were British-paid.)[77]

The problem was that this network of active research, substantive as it seemed, contrasted rather negatively with what was known of the American position. American research costs were thought to be running at $350,000,000 per year, and at least 500 graduate-level research staff were known to be employed in universities and government labs (*i.e.* five times more than the *combined* total in Canada and the UK).[78] The British were, however, sceptical of some American claims.[79] Even allowing for a healthy degree of scepticism, though, it was clear that an independent British programme would trail the Americans by a fair margin. It was calculated that for the United Kingdom to produce 1kg U235 per day via the diffusion method would cost approximately £50 million and take between three-and-a-half and five years to build (including 9-12 months of preparatory work before construction could even begin). The Americans, in contrast, believed that their plant would be ready in 'about 2 years'.[80] The position was summarised neatly in mid-April in a document containing an 'outline of further effort and time needed to achieve full-scale realisation of T.A. 1 and T.A. 2 projects without American co-operation'.[81] On T.A.1, it was concluded that a significant expansion was required right across the board. Chadwick, working on bomb design, would need perhaps another ten or so senior physicists, plus juniors and support staff; Peierls too might need more support. Design and construction of a diffusion plant would require a far greater commitment: 220 chemists, physicists, metallurgists & engineers; 500 research assistants; 50 administrative workers, and a further 150 skilled and 300 unskilled workers for construction. Only about 90 of the scientists were already available. Design work would require a further, shorter-term commitment of personnel, peaking at an additional 50 engineers and 780 support staff for design of the plant. The Americans would clearly beat the British to the bomb. That said, it was clear at least that an independent programme was technically feasible. This gave

[75] Halban to Akers, 25th March 1943, AB 1/374 (TNA)
[76] *viz.* ICI Fertilizer & Synthetic Products; ICI General Chemicals; ICI Metals.
[77] Outline of nature and scale of present British effort', 16th April 1943, AB 1/374 (TNA)
[78] Ibid.
[79] Ibid.
[80] T.A. Project – Note for Lord Cherwell, 6th April 1943, AB 1/374 (TNA)
[81] Outline of nature and scale of present British effort', 16th April 1943, AB 1/374 (TNA)

the British the essence of a strategy: they could inform the Americans, in detail, of British plans for full-scale development. There was a faint possibility that this might at last persuade the Americans to accept some new form of collaboration, whilst in the more likely case that they were to decline the British could instead rely on Canadian support.

This strategy, of course, rested on Canadian willingness to sever nuclear relations with the United States, and was therefore optimistic at best. Even in January Mackenzie had seen little option for Montreal but acceptance of the Conant restrictions, and after months of stalled negotiations his pessimism had only deepened.[82] Both he and Howe had become impatient with British machinations, and were increasingly tempted to wash their hands of the whole project. At one discussion, in May, the two had agreed that 'if United Kingdom would not accept American proposal at once, we would not carry on the project'.[83] Shortly thereafter Mackenzie informed Akers of his view

> that the break with the Americans entirely alters the position of the Canadian Government, whose co-operation with [us] was on the basis that this brought them into [a] project where the British [and] Americans were working together.[84]

Here was Canadian independence of thought and action made manifest. The British had long assumed that Canada was inherently on the British 'side', and that Canadian decisions, even with regard to Canada's relationship with the US, would be taken with a view to British interests in their widest conception. They were wrong. The Americans, in fact, had been closer to the truth in their assumption that Mackenzie's position lay closer to their own than to the British.[85] It was now becoming clear that Canadian engagement with the nuclear work had not solely been an act of imperial assistance, nor even of pragmatic self-interest: rather, it had been conceptualised, from the outset, as a tripartite endeavour, with the United States at the head. In the nuclear realm, as in wider politics, it was now increasingly the American relationship which undergirded Canadian policymaking. This had troubling implications for British policy.

> Unless relations can be restored between the British and Americans, it means that the Canadian Government has got to choose between us. In this case they will undoubtedly refuse to take any action which will antagonise the American Government, as the effects of a breach will be too serious.[86]

The British strategy of confrontation, was, in short, unworkable. Yet it was not immediately abandoned. A further round of talks between Churchill and Roosevelt inspired fresh hope of resolution, and alongside it fresh consideration of the possibility of putting pressure on the Americans by stressing Britain's absolute commitment to large-scale work.[87] Yet even Perrin had cooled on the idea that the Americans might be manipulated by what amounted to a bluff:

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[82] Peierls to Akers, 1st May 1943, AB 1/374 (TNA)
[83] CJM diary, 1st May 1943
[84] Akers: Note on Talk with C.J. Mackenzie, 14th May 1943, AB 1/374 (TNA)
[85] Hewlett and Anderson, *The New World,* p.272
[86] Akers: Note on Talk with C.J. Mackenzie, 14th May 1943, AB 1/374 (TNA)
[87] Akers to Chadwick, 28th May 1943, AB 1/374 (TNA)

> the prospects of restoring practical collaboration would be nil if our representatives entered the negotiations with the intention of what amounts to holding a pistol at the American heads…[88]

Perrin therefore thought it might be best that the British simply resign themselves to a separation.[89] Anderson, in contrast, felt that a statement of intent, not levelled as a threat but presented as an indication of British commitment to action, might serve a useful purpose in inclining the Americans towards an agreement. It was even hoped that the Canadians might be willing, as they had not been six months previously, to represent the British position to the Americans; Akers thought it would be 'even more impressive' if Bush and Conant learnt of the plan for a full-scale Anglo-Canadian development programme via Mackenzie.[90] It was a forlorn hope, however. The Canadians were still in no mood to intercede for the British. Mackenzie's diary speaks of Howe's annoyance at the United Kingdom attitude: 'at the slightest cause I think he would close the whole thing down'.[91] For Mackenzie and Howe the British offer of '50/50 development', which some in London thought so attractive, paled in comparison with the potential consequences of a breach with the Americans.[92]

The development which broke the impasse, when it came, was almost anti-climactic. In July 1943 Bush and the American Secretary of War, Henry Stimson, were both in London on other business, but Churchill, Anderson and Perrin were between them able opportunistically to corral the Americans into a series of discussions on Tube Alloys, in the course of which the Americans at last conceded that suspicion of British post-war industrial objectives had contributed to the Americans' opposition to close collaboration. By immediately offering a sweeping (perhaps disproportionate) concession on this, the British were able to short-circuit the American argument, whilst simultaneous personal pressure by Churchill on Stimson (and therefore indirectly upon Roosevelt) at last produced favourable conditions for progress. By 31st July, Mackenzie could note in his diary that matters were 'taking an optimistic turn'; when he saw Anderson on the 3rd August he found him 'a different man'.[93] A swift series of negotiations, first in London, then in Washington, produced a draft agreement in time for Roosevelt and Churchill to approve it at their conference in Quebec (hosted by Mackenzie King, who nevertheless took little part) in August 1943.

The five concise articles of the Quebec Agreement encoded a mechanism for the direction of the entire subsequent allied nuclear programme. The drafting was, however, somewhat ambiguous on key issues (a fact which may have recommended it to both parties, for each could see in it an interpretation compatible with their own desires). The first two clauses were uncontroversial, for neither party was likely to wish to use the weapon on the other, and by 1945, American predominance in both the nuclear endeavour and the direction of the Pacific War meant that British consent to the use of the weapon against Japan was largely a formality (though British personnel participated in, amongst other things, the selection of targets). The third clause, though, prohibiting the communication of information to third parties 'except by mutual

[88] Gorell Barnes to Anderson, 24th June 1943, AB 1/374 (TNA)
[89] Ibid.
[90] Extract from Akers letter, 24th June 1943, AB 1/374 (TNA)
[91] CJM diary, 10th July 1943
[92] Extract from cable, MacDonald to Anderson, 30th June 1943, AB 1/374 (TNA)
[93] CJM Diary, 3rd August 1943

consent', was already mired in complexity. For one thing, there was already the vexed question of Halban and his French colleagues, whom the Americans had never fully trusted (and never would). More complex still, there were the Dominions: were they to be treated as a third party? Canada was not a signatory to the agreement, but would be represented on the Combined Policy Committee which the agreement established: a clear exception. But what about Australia, already cognisant of the programme through Oliphant? The fourth article, meanwhile, contained the great concession of post-war industrial applications, whereby the British disclaimed any interest beyond what the American President would permit, and the fifth article outlined the mechanisms by which this agreement would proceed, and contained the crucial rubric around 'full and effective interchange of information and ideas'.

In the final analysis, then, the British objective of securing a tripartite nuclear programme was achieved, not by the policy of resistance, the brief application of which had only made matters worse, nor by a policy of acceptance, for this was never tried, but by a combination of attritional negotiation at the lower levels and the 'moral suasion' exercised by Churchill on Roosevelt.[94] That it should finally have been achieved so straightforwardly has puzzled historians. Septimus Paul, perhaps in consequence of having read too much into Churchill's phraseology,[95] focuses on the image of Churchill grovelling at Roosevelt's feet – 'a low point in the dignity of the office' – as though it were British abasement that finally convinced the Americans.[96] Avery's description of Quebec as Conant's 'private moment of triumph', as though the British had been bound to something equivalent to his original proposal, is similarly misleading.[97] The British certainly accepted junior partnership, and certainly submitted themselves to the onerous burdens of American compartmentalisation policy, but they also gained their primary goal of collaboration across fast and slow neutron research – including on the electromagnetic and centrifuge methods, for which the British did not have corresponding programmes. In that sense, given how bleak the situation had appeared eight months previously, it bordered on the miraculous.

Both parties were ultimately drawn to Quebec by a gradual realisation. For the Americans, it was the realisation that in spite of their sacred new policy of compartmentalisation their programme had become almost inextricably intermeshed with the British,[98] and that since the British could not be deterred from pursuing a large-scale programme of some sort, condescending to some form of collaboration was the safer, easier option. For the British, it was the realisation that the Canadians could not be induced to support any policy amounting to a complete breach with the Americans, and that Britain could not realistically pursue its nuclear ambitions without Canada. Montreal had become too important, as a centre in its own right and as one of Britain's few tangible nuclear assets, for it to become simply a minor research laboratory for DuPont – which meant that a policy of meek acceptance of the Conant restrictions could not be countenanced. Without Canadian support, meanwhile, there were no meaningful methods by which pressure could be placed on the Americans; nor could they simply walk away. So it was that the British, lacking any other policy option, simply held the line – and this, paradoxically, worked. Their initial policy

[94] Barton J. Bernstein, 'The Uneasy Alliance: Roosevelt, Churchill and the Atomic Bomb, 1940-1945', *The Western Political Quarterly,* 29:2 (1976), p.212
[95] He makes much, for example, of Churchill having written 'I beg you to let me know', though this was not quite the abasement it might sound to modern ears. Septimus H. Paul, *Nuclear Rivals: Anglo-American Atomic Relations, 1941-1952* (Columbus: Ohio State University Press, 2000), p.32
[96] Paul, *Nuclear Rivals,* and *cf.* p.47: '[Churchill] swallowed his aristocratic pride]' *etc*.
[97] Avery, *The Science of War,* p.187
[98] *cf.* Jones, *Manhattan*, p.271

of investing in the heavy water work as a method for binding together the British and American fast neutron programmes had, almost miraculously, and certainly in spite of subsequent vacillations in British policy, proven successful. In short, although Quebec was a wholly bilateral agreement, it could not have been concluded had the Canadian influence not been felt.

Conclusion: A Salvage Operation?

The crisis in Anglo-American nuclear relations that had begun in January 1943 created the conditions which led ultimately to the Quebec Agreement. It was a crisis which the British should probably have foreseen. Yet the British were undone not so much by complacency or arrogance, as by naïvety. In 1942, the British impulse had been to avoid the entanglement of the British and American programmes by sharing only information, rather than resources: a policy of close co-operation, stopping short of a formal commitment to joint development. Politicians and scientists had alike assumed that priority in discovery would carry some weight; that early progress could easily be parlayed into continuing relevance; and that rivalry between the Anglophone allies would never supersede the principles of fair play and common cause. Yet generosity carries no obligation in diplomacy. Good will is a diminishing resource, and by the time British thinking had become more amenable to the idea of a North American home for the programme much of the intangible asset of primacy had vanished. The problem was almost, in fact, that the British had been conceiving of the Americans as though the US were a Dominion, in the idealised sense; Akers, Anderson *et al* seem genuinely to have struggled with the idea that an Anglophone democracy, allied with Britain in the same hard-fought conflict, might nevertheless choose to act in such a way as to enhance, intentionally or incidentally, its own position *vis-à-vis* the United Kingdom. The British were psychologically anchored on their early experiences of co-operation, particularly with regard to Conant, for whom they long persisted in making excuses. The attempted imposition of the Conant restrictions in early January meant that British illusions could no longer be sustained as anything other than wishful thinking.

Once it had become clear that the difficulties with the Americans were no simple case of miscommunication or interpersonal difficulty, it became necessary for Britain to develop a coherent policy response. One possible option was to seek some form of resolution on the basis of a redoubled effort in Britain and by the British in Canada. For some, this was only ever to be as leverage for negotiations with the Americans; for others, there was solace in the idea that an 'independent' programme might actually deliver on Britain's ultimate policy objective of remaining at the cutting edge of nuclear research. Ranged against this policy of confrontation, which had its adherents mostly in Britain, was an argument in favour of accepting the Americans' demands, which was advanced most clearly by those more closely affiliated with the Montreal Laboratory, British and Canadian alike. The British spent much of the first part of 1943 suspended between these two incompatible policies. From either perspective, however, Canada's importance to Tube Alloys had dramatically increased, for having spent the final few months of 1942 diligently entangling their heavy water team with the Canadians at Montreal there was now no option but to engage closely with them. Paradoxically, this experience at once managed to draw the British and Canadians closer together, and to reinforce the distinctions between them.

Collaborating more closely with Canada eroded the last residues of the core-periphery dynamic which had previously informed British policy-making. Prior to the Conant crisis the British could conceive of Canada in one of two ways – as a territory in which to act, or as a sovereign entity with which to engage. The British had begun their nuclear adventure conceiving of Canada chiefly in the former manner, but by mid-1943 this was no longer possible. Canada the territory and Canada the sovereign entity could no longer be disaggregated: the project on Canadian soil in which the British had invested so heavily, financially and psychologically, had inexorably transitioned into a joint enterprise with the Canadian state. Shorn of the American collaboration they had taken for granted, the Tube Alloys organisation fell back on what was familiar and available. Desperation, rather than inclination, led the British to engage seriously with the idea of Montreal as a stand-alone project. Not for the first time, the British found themselves looking to a Commonwealth partner to help overcome a setback. Yet as Mackenzie consistently demonstrated, Canada was not straightforwardly subaltern. It was the dawning realisation that Canadian support in the nuclear endeavour must now be earned, rather than assumed, and that the Canadians were increasingly inclined to sympathise with American rather than British perspectives – that tempered the British impulse to pursue radical independent options.

In the final analysis, then, Canada's emergence as a participant in the nuclear endeavour can be seen as the result of two distinct but inter-related processes. First, it was the unintended consequence of the almost absent-minded delegation of administrative authority to the NRC which meant that the crucial influence at a moment of crisis lay in Canadian as well as in British hands. Second, it was the conscious reconfiguration of British plans around the idea of an Anglo-Canadian project at Montreal which – although never enacted – forced the Tube Alloys establishment to engage more seriously, and more directly, with the potentialities of an Anglo-Canadian programme. Thus, ultimately, it was the temporary breakdown of the bilateral US-UK relationship and the concomitant discovery of the Canadian conception of their participation in the project as dependent on American support that led to the consolidation of the tripartite collaboration in the form of the Quebec Agreement.

Chapter Four:
Canada after Quebec

Any hope that the Quebec Agreement might lead to an immediate revitalisation of the Montreal Laboratory faded with astonishing rapidity. Instead of progressing immediately into the sunlit uplands of swift action and easy collaboration, which a roseate reading of the agreement seemed to promise, the British found themselves entering perforce into yet more laboured, often labyrinthine, negotiations – a continuation, in a sense, of those which had preceded the signing of the Quebec Agreement.

This chapter traces the development of the Anglo-Canadian nuclear project from August 1943 onwards. It seeks to untangle the complexities of British, Canadian and American nuclear policy interactions in this period by paying closer attention to the underlying diplomatic, strategic and imperial dynamics. The focus here is purely on Canada and the Canadian project. Parallel developments elsewhere, involving Australia, New Zealand and the wider British Empire, are discussed in Chapter Five. These two chapters, read together, amount to a full history of British and Dominion engagement with nuclear weapons research from the Quebec Agreement to the end of the war. Less prominence is given to the processes by which British personnel were incorporated into the Manhattan Project, in part because tolerable accounts of these processes already exist,[1] and in part because to focus too closely on these could only be at the expense of a closer examination of the complexities of the tripartite discussions as to the fate of the Canadian project, the relevance of which this thesis seeks ultimately to demonstrate.

The chapter proceeds chronologically, from an elucidation of the initial struggle to convert the rhetoric of the Quebec Agreement into practical action, through an examination of British perspectives and underlying premisses as these negotiations evolved, to an analysis of the ultimate 'triangular' nuclear relationship in practice. At each stage the intention is to disaggregate the uniquely British and Canadian perspectives during this period, and to account more holistically for the two states' interactions than previous scholarship has attempted. Underpinning all this are the twin convictions, gleaned from the archival record itself, that in spite of appearances the work in Canada was no mere sideshow to the main event at Los Alamos but rather a crucial influence on the early history of the atomic bomb, and that from the levels of high diplomacy to the individual experiences of scientists and administrators, the tensions and assumptions associated with Dominionhood were an active, if often nebulous, force.

Whither Canada?

The agreement signed at Quebec, achieved after many gruelling months of diplomatic effort, seemed to the British to augur instantaneous change for the better.[2] In expectation of immediate action, Oliphant, Peierls and Simon had been despatched to the United States even before agreement had formally been reached.

[1] See *e.g.* Szasz, *British Scientists and the Manhattan Project*, a good, but incomplete, analysis, and Gowing, *Britain and Atomic Energy*.
[2] *cf.* Eggleston, *Canada's Nuclear Story*, p.89

They arrived in the United States on the 19th August, only to be informed by their American counterparts that nothing could be done until the newly-conceived Combined Policy Committee had met. John Llewellin, one of the two nominated British members, spent much of the next fortnight trying to secure this first meeting, but Stimson and Bush – two of his American counterparts – were each either unavailable or evasive. Informal discussions with Conant were the best that could be achieved until Stimson at last became available, in the second week of February.[3] Whilst the Americans were proving difficult to pin down, the Canadians at least seemed agreeably complaisant. Howe, the designated Canadian member, appeared to be intensely relaxed about his nation's representation; he declared himself 'completely satisfied' to delegate to Mackenzie where appropriate and, more strikingly, was also 'quite content to leave the Canadian side of any question in the hands of the British delegates'.[4] Such an attitude on the part of the senior responsible Canadian implies that in spite of the notionally tripartite composition of the CPC (or perhaps, in part, because of it) the Canadian government still conceived of itself in some respects as a junior partner in the British programme, rather than a discrete participant in the wider allied effort. This attitude, which reflected the bipartisan nature of the Quebec Agreement, would not necessarily endure.

For the time being, the question of Canadian representation mattered little. The initial discussions were effectively bilateral, with the Americans setting much of the agenda. In this they were overwhelmingly task-oriented, and the actions they envisaged were *ad hoc* rather than programmatic: they wanted specific individuals for specific tasks. They were keenest to get hold of Chadwick and Oliphant specifically and 'senior physicists' more generally, the latter to be distributed between Los Alamos and the uranium enrichment teams.[5] The British position that 'the most effective method of collaboration will be to join forces as fully as possible', which would involve the placement of the best of the British scientists in appropriate groups in the United States proved complementary to this approach.[6] The outline of a plan therefore began to emerge, with names and locations pencilled in: Chadwick, based either at 'Y' (the Americans' secret camp at Los Alamos) or in Washington, would have seniority within the British contingent. Oliphant would initially go to Berkeley to work with Lawrence on electromagnetic separation, before joining the team at Y. Some limited support would be given to the diffusion work, probably by Peierls and a handful of colleagues. For the British, this all constituted progress. What mattered was that there would be a British contingent working within the American programme, with American blessing.

The exception, perversely, was Montreal. Groves had visited on 18th September – a good first step – but as yet there were no guarantees that the laboratory would have any part to play in the post-Quebec collaborative structure. It was all very well discussing a proposed budget for Montreal, as the laboratory leadership did that autumn, but nothing could actually be decided until Montreal's future programme was known. This depended on the formulation (and acceptance by the CPC) of Anglo-Canadian proposals for slow neutron work, which in turn depended both on the trajectory of the wider British programme and the Americans' attitude to it.[7] Neither variable was yet settled. The British were caught in somewhat of a bind: they dared not push too hard on Montreal, even though the Quebec Agreement itself had been sought in an

[3] 'Negotiations with the Americans after the Signing of the Quebec Agreement', Akers, 13th September 1943, AB 1/129 (TNA)
[4] Ibid.
[5] 'Meeting at War Department', 13th September 1943, AB 1/376 (TNA)
[6] 'Notes for conversation with Groves and Tolman', 23rd September 1943, AB 1/376 (TNA)
[7] Akers to Mackenzie, 18th October 1943, AB 1/376 (TNA)

effort to save it. There was now something circular, even contradictory, in British policy. The British sought the fullest possible access to the American project, and were inclined to reject 'partial' collaboration; and yet they could not afford to imperil collaboration by seeming to violate the spirit of the Quebec Agreement. It was a challenging negotiating position for the British representatives to maintain, and it was recognised that they might have to play their hand in such a way that any ultimate decision could be left to the Prime Minister.[8] Montreal had thus become an unwelcome complication. Its ultimate purpose was ambiguous, and its relevance to the American programme unclear. Little wonder that the American leadership, already sceptical of any work that lay outside their country's borders, still hesitated to commit American resources to the laboratory. The complexities of the Montreal position could even be described as having acted as an anchor on the negotiations around other aspects of the programme, which might otherwise have proceeded more smoothly. The lack of any substantive agreement in late 1943 certainly had a deleterious impact on the life of the Montreal laboratory. Plans for further staff transfers had to be put on hold.[9] Morale began once more to decline. By November, Akers was forced to confess to Halban that he had been 'too optimistic in [his] calculations about how long it would take to get definite decisions agreed with the Americans'.[10] He insisted that progress was being made, but the impression is one of a brave face. As the year ended it seemed as though the British were, in fact, back in the familiar territory of negotiating in the face of American obfuscation, with Groves and Conant the familiar antagonists. (Paul suggests that Bush and Conant, unreconciled to Quebec, sought to erect barriers to collaboration where possible: there may be a modicum of truth in this, but the great advantage of the CPC system was that it at least created a forum in which such barriers could be challenged on the record.)[11]

The British were forced to play a delicate diplomatic game. Groves had made clear the American position that heavy water work was considered a secondary priority – something they were willing to countenance the Canadian Group working on, but not at the expense of the core project.[12] The Americans' (relative) disinterest worked in Montreal's favour, for so long as good progress was being made in high-priority areas it would be possible to make modest proposals for Montreal without attracting American opprobrium. The duty of negotiation now fell to Chadwick, for Akers, who as an ICI man had never found favour in American eyes, had been quietly rotated away from his liaison role in September.[13] Central to Chadwick's approach was the deft handling of the relationship with Groves, and a corresponding effort fully to appreciate the American perspective. Much intellectual effort was expended on the latter within Tube Alloys. When the T.A. Technical Committee met in New York in January 1944, it was considered possible that Groves' reticence might stem from concerns with the diffusion project. If this were, as seemed possible, to be cancelled or scaled back, its budget might possibly be used for an American effort on heavy water.[14] This, however, would imply that American interest in heavy water was contingent on the success or otherwise of the diffusion work – an approach which would be at odds with the Americans' established practice of running each aspect of the programme in parallel. Moreover, it seemed that Groves rather

[8] Anderson to Llewellin, 20th October 1943, AB 1/376 (TNA)
[9] Akers to Webster, 8th December 1943, AB 1/1 (TNA)
[10] Akers to Halban, 3rd November 1943, AB 1/129 (TNA)
[11] Paul, *Nuclear Rivals,* p.58
[12] Minutes of meeting in Chicago, 8th January 1944, RG77-D-1-b. Box 284 'Radiological Research: Policy, Vol. 1' (LAC)
[13] CJM diary, 12th September 1943
[14] Minutes of TA Technical Committee Meeting in NY, 4th, 6th, 19th, 20th January 1944, AB 1/550 (TNA)

favoured the idea of a large-scale effort in Canada as going some way to 'balancing' the UK effort with that of the US.[15] Chadwick also believed Howe would be amenable to a three-way programme if it had good prospect of success.[16]

Chadwick, instinctively acknowledging a dictum of Akers' that 'Groves does not like to be hustled',[17] worked patiently to persuade Groves and his colleagues of the merits of the British case, and by the end of the month, when it had been decided that the question of whether Montreal should host a large-scale effort on heavy water reactors would be resolved by the CPC, he had reason enough to be positive, since in his view 'the American approach towards co-operation [had] been excellent', giving Montreal 'everything we could reasonably ask for at this stage'.[18]

One thing, however, was clear: Groves had explicitly stated his unwillingness to give heavy water for use in England instead of Canada.[19] As had always been the case, the price of American collaboration was the basing of the work in North America. The hope of an independent UK-based programme, which had been considered once in the dark days before Quebec, and been ruled out, was nevertheless revivified by a frustrated Perrin, who seeing the American stance as still overly restrictive argued instead for a refocussing of British efforts on activity in the UK, both on heavy water reactions and enrichment of U-235. Such a policy would require Britain to bring back 'as many of the Montreal team as will come'.[20] Chadwick could sympathise with this impulse towards a more independent programme, but thought it unwise, given the circumstances. Writing in early February, he noted that

> The American effort is on such a scale that we could not compete with it even in peace time. We could not, for example, devote the number of scientists required for the project at this stage without paralysing our Universities…. It is essential that we should acquire the fullest possible knowledge and experience of all phases of the project so that we shall be in a position when the time comes to start work in England on the right lines, profiting by American experience.[21]

In other words, quite apart from the Quebec obligation to secure a nuclear weapon for the allies as soon as possible, a degree of subordination to American strictures was in the long-term national interest. Conversely, a small-scale, introverted programme would leave the United Kingdom adrift, detached from the cutting edge. In the same way, too combative an approach on the issue of Montreal would imperil the gains made by the British contingent in the United States, which aspect of collaboration appeared to be working well. This was not to say that collaboration would be unlimited. Sensitive subjects such as plutonium separation chemistry were likely to be off-limits, at least for the time being. Still, the prognosis seemed reasonable: Chadwick was 'convinced that true co-operation will be established'.[22] From his

[15] Minutes of TA Technical Committee Meeting in NY, 4th, 6th, 19th, 20th January 1944, AB 1/550 (TNA)
[16] Ibid.
[17] Akers to Perrin, 24th January 1944, AB 1/682 (TNA)
[18] Webster to Perrin, 28th January 1944, AB 1/481 (TNA)
[19] Minutes of TA Technical Committee Meeting in NY, 4th, 6th, 19th, 20th January 1944, AB 1/550 (TNA)
[20] Perrin to Akers, 12th January 1944, AB 1/376 (TNA)
[21] Chadwick to Perrin, 3rd February 1944, AB 1/481 (TNA)
[22] Chadwick to Perrin, 5th February 1944, AB 1/113 (TNA)

knowledge of the situation, he could see that the stakes were high: '[Montreal] is a somewhat disorganised and unhappy place at present and, unless I can bring off the large scale proposal, I see a very poor future'.[23] On the other hand, the prospects for an agreement seemed good:

> Our relations with the U.S. are excellent. Our standing at the moment is very high indeed and it will be fortunate if we can retain such a level. I am trying to make every use of our reputation while it is still good.[24]

An actual agreement still lay some way off, but some of its prerequisites were becoming clear. One source of American disquiet over Montreal was traced to 'mistrust' of the present management. Chadwick did not concur in the diagnosis ('I do not go so far as that') but he agreed with the prescription: new leadership was needed. All three nations agreed that John Cockcroft was the man required: Chadwick thought him 'essential'.[25] This question of leadership is one to which this chapter will return; for the time being it is important to note the significance of Cockcroft in British, American and Canadian eyes. This significance is reflected in the record of an informal meeting held by the Montreal team on 14th February. After more than a year's delay, the personnel of the laboratory were understandably impatient. Immediate agreement to a full scale plant in Canada would be the ideal, with or without complete interchange on chemistry. Whatever the outcome, though, it must be enough to justify bringing Cockcroft in; this, in fact, now became their main criterion for whether they were satisfied. A lesser programme – a pilot plant only – might still be acceptable, provided the overall programme was sufficiently ambitious as to merit Cockcroft. This did not necessarily betoken dissatisfaction with Halban as a leader (he himself being present at, and active in, this discussion) but rather represented the extent to which Cockcroft had become emblematic of the serious, worthwhile project which the members of the laboratory ultimately demanded. The need was pressing:

> it was quite certain that the members had now reached a stage where they were so dissatisfied… that they were on the point of asking to be allowed to resign or to be transferred.[26]

Turning to the wider implications, the meeting agreed that if the worst should happen – if no satisfactory programme could be agreed – each government would ultimately have to decide for itself what course of action to take: Halban's own idea was that a skeleton staff should be kept on, to keep things ticking over, with all others to be given leave of absence for other work, then to reconvene the group after the war.[27]

The pressure, then, was squarely on Chadwick's shoulders. He had continued to focus his entreaties on Groves, but Groves had deferred to Conant, who in turn declared it a question for the CPC. This was reasonable enough, but engineering a meeting of the CPC was somewhat less than straightforward; just as the CPC itself had taken time to establish, the scheduling of meetings was now becoming a recurring

[23] Chadwick to Perrin, 5th February 1944, AB 1/113 (TNA)
[24] Ibid.
[25] Ibid.
[26] 'Notes on the Informal Meeting of the Montreal Members of the Technical Committee on Radiological Research, held in the Laboratory on February 14th, 1944', AB 1/164 (TNA)
[27] Ibid.

problem. For one thing, 'Howe's presence is absolutely necessary for Canada's consent and he has been completely tied up'.[28] (No suggestion here that Howe's earlier professed willingness to be represented by the British members be taken at face value: a decision principally about Canada self-evidently required Canadian buy-in. In the event, Howe missed the meeting, his plane having been grounded at the last minute, but Mackenzie attended instead, and gave 'some degree of support').[29]. The British representatives, Dill and Campbell, were eventually able to make their case for a large-scale heavy water programme in Canada at the February meeting of the CPC, but the American representatives wanted more information. The matter was referred to a sub-committee.[30] Comprising Groves, Chadwick and Mackenzie (note the strictly balanced tripartite composition) it worked well enough when its members were able to convene, but was held up by Groves' frequent visits to the far-flung sites of the Manhattan Project.

Although the forum of the subcommittee notionally afforded them an equal voice with the British and the Americans, the Canadians were far from pro-active participants in the negotiations. Wrote the British members of the CPC to Anderson:

> You should know that though Howe and Mackenzie see great advantages of project for Canada, indications are that they are not anxious to try actively to influence the decision. H[owe] regards matter as one for United Kingdom and United States Governments and would accept their decisions[31]

This was not indifference on the part of the Canadians, for they had invested too heavily to be truly unconcerned, but rather a tactical reticence, arising from their sensitivity to the trilateral diplomatic tangle in which they found themselves the junior participants. To participate more actively in the discussions would have risked the appearance of picking sides, and Canada's strategy was above all to avoid such a dilemma. Better, then, to allow Britain and the United States to resolve their disputes bilaterally, for this, indeed, constituted the most desirable outcome from Ottawa's perspective – assuming, of course, that the outcome of the bilateral process was not deleterious to Canadian interests.

Anderson wrote to Chadwick and the two British representatives referencing the 'danger' that the American representatives might suggest arrangements

> which would, on paper, appear to justify the continued existence of our team in Montreal but which would, in fact, provide no certainty of a large-scale heavy water pile being built in Canada.[32]

In such a scenario the Montreal laboratory would again be consigned to an awkward, hollow existence, conducting little or no useful work but still consuming valuable resources. A draft version of this message was more intemperately phrased, expressing a fear that the Americans might present options which would

[28] Chadwick to Perrin, 5th February 1944, AB 1/113 (TNA)
[29] Dill & Campbell to Anderson, 24th February 1944, AB 1/113 (TNA)
[30] Ibid.
[31] Ibid.
[32] Anderson to Campbell, Dill, Chadwick, 29th February 1944 (and draft), AB 1/113 (TNA)

not be 'justifiable or fair'. If that were the case, Anderson thought it would be better to 'retain complete freedom to decide their future for ourselves'; that is, to recall the team and strike out alone.

Fears of further American obstreperousness were valid. Conant in particular seemed intent that any decision be based on a 'strict interpretation' of the Quebec Agreement, which given its probable timescale would seem to rule out heavy water work. This would present the British with 'something of a dilemma'. As they were now forced to admit, if only to themselves,

> the real reason for which we attach importance to this project is that we believe that, although slower to come to fruition, it may well, in the long run, prove the simplest and most economical method of producing a military weapon.[33]

That is, the British wanted the heavy water project because they wanted to retain the option of an effective long-term weapons programme. Yet the Quebec Agreement, so fervently desired a year ago, was predicated on the idea that the collaborative programme was to be planned in relation to the war effort alone. This 'absurdity' seemed inescapable in light of the firmness of the Americans' attitude.[34] It therefore followed that a programme in the UK should be considered. The Americans would be just as opposed, again on grounds of the Quebec Agreement, but the UK could argue that the CPC was 'not a supra-national body and that in the last resort each Government is free to take its own decisions'.[35] The practical upshot for the British was obvious: 'We are clearly on very delicate ground'.[36] The British were, yet again, in a bind over the workings of the tripartite relationship:

> Nothing but a willing agreement of the U.S. authorities to proceed with our proposal as a joint project will be of any use to us. Even if we succeed in forcing the Americans to agree, in principle, against their real desire, to the execution of a project on a combined basis, they would obviously be able to wreck it by obstructive tactics. And experience shows that the Canadian Government, owing to their material dependence on the Americans, would feel unable to join us in fighting such obstruction. In this connection it seems questionable whether we would achieve any concrete results by attempting to enlist Mr. Howe's personal support; and, owing to Mr. Howe's "casualness" there is always the danger that the Americans would come to hear of any such approach to him.[37]

The British were gradually coming to realise the Canadians' structural dependence on the Americans. Paradoxically, the Quebec agreement had solved their fast neutron problem, but not their heavy water. The British were left fighting for a programme in Canada without direct Canadian support, and with the strong temptation to abandon it.

[33] 'Notes on ANCAM 16 and ANCAM 17', February 1944, AB 1/113 (TNA)
[34] Ibid.
[35] Ibid.
[36] Ibid.
[37] Ibid.

Questions of Leadership

On-site in Montreal, too, things were becoming more complicated. Longstanding administrative issues were now increasingly freighted with diplomatic implications. The laboratory's hastily devised administrative structure had been found wanting, but was already too firmly entrenched to be easily reformed. Threaded through all of this was the question of leadership. This difficulty has already been alluded to, but merits close attention, for from the articulation of difficulties around leadership emerged broader themes.

The hasty *ad hoc* creation of the Montreal Laboratory, and the blurred lines of the wartime Anglo-Canadian relationship more generally, meant that by the autumn of 1943 confusion had arisen 'concerning the relationship of the Laboratory to the U.K. and Canadian ends of T.A.'.[38] The responsibilities of each party were inadequately delineated, and it was unclear which forms of communication and direction were legitimate. Re-reading the original memorandum governing the creation of the laboratory, it seemed clear enough that Montreal lay under the actual jurisdiction of the NRC, even if much of the direction had thus far emanated from London. A process of administrative untangling followed. It was agreed that 'free channels of communication' should exist between the policy committees in Montreal and London, between Mackenzie and the whole of the Canadian organisation, and between Chadwick and both organisations.[39] This clarity benefitted both countries, but amounted to an actual strengthening of the Canadian character of the Montreal project. Crucially, all involved agreed that the theoretical route by which Halban could bring his concerns directly to MacDonald, the British High Commissioner, should be closed; Mackenzie had viewed this as potentially 'short-circuiting' the NRC. Such refinements give the lie to the idea that the Canadians were only ever acquiescent hosts, giving the British free reign on their territory. It had never quite been so, and Canadian engagement with the nuclear work at Montreal grew steadily as the war progressed.

Amongst these very sensible administrative reforms there also was raised the idea that an administrative director might be appointed, to ease Halban's burden and act against 'certain frictions' between him and the NRC. The expectation was that such a director should be a Canadian.[40] This was the first suggestion that the laboratory might require some form of leadership restructure, though the long months of discontent had helped foster a sense that something would soon have to change, and Halban, as the laboratory's figurehead (and, in the earliest stages, almost its *raison d'être*) became its focal point. The Canadian writer Wilfrid Eggleston's early account of Canadian nuclear research makes no reference to the idea that there was dissatisfaction with Halban's leadership *per se*, instead, construing Mackenzie's emerging keenness for new blood only in the positive sense of wanting an 'Anglo-Saxon' of the Chadwick-Oliphant calibre to head the laboratory.[41] (This chauvinistic preference for 'Anglo-Saxon' leadership was as much Canadian as British;[42] despite its location, vanishingly few of the scientists and technical staff at Montreal were

[38] Meeting at Montreal Lab, 19th September 1943, AB 1/379 (TNA)
[39] Ibid.
[40] Ibid.
[41] Eggleston, *Canada's Nuclear Story*, pp.91-92
[42] CJM diary, 27th August 1943

French-Canadians – an absence hitherto noted only by Quebecois historians.[43] Later accounts, though, made much more of Halban's personality, with most – including the prominent American narratives – portraying Halban as ineffective and divisive. Hartcup and Allibone, Cockcroft's biographers, subscribe to this idea of Halban as poor leader, explaining that he 'ran the Laboratory in an atmosphere of extreme secrecy and would not tell McKenzie [sic] or other Canadians about decisions regarding the research program' – hence the need for a new head, acceptable to US and Canadians.[44] Gowing's interpretation is more even-handed, but accepts the essential premise that Halban was the source of discontent; Avery recognises that Mackenzie undermined Halban somewhat, equally does not exculpate Halban.[45]

The principal source for the narrative that Halban was the problem was Mackenzie, whose diary paints an extraordinarily critical picture of his colleague: Mackenzie thought Halban 'a mere child and a temperamental one at that'.[46] Yet a close reading of the archives suggests that Halban may well have been a man more sinned against than sinning. His own diary for the period is as partisan as one would expect, but makes clear at least that there were serious differences of opinion between him and Mackenzie. There are multiple references to facets of 'the Mackenzie problem', and a marked frustration with the allegedly limited extent of Mackenzie's engagement with the minutiae of the laboratory's research programme. Bluntly, Halban felt that Mackenzie was 'not in a position to comment on technical performance of the lab'. More seriously still, Halban's diary contains the suggestion that Mackenzie misunderstood the very purpose of the laboratory: as Halban had it, Mackenzie had yet to acknowledge that the team at Montreal were 'working not on power production but 49 and 23 production'. If Mackenzie had failed to comprehend this, it could only be because he had paid inadequate attention to the laboratory from the outset. Thus, if Halban's accusations have any merit, it would seem he was caught in an awkward situation. If Mackenzie was both ill-informed and inadequately engaged, he could only really act as a constraint on the laboratory's activities. It would have been better – for Halban at least – to have had either Mackenzie's blind confidence or his informed engagement.[47]

Halban's own writings are not the only source to suggest difficulties with Mackenzie in this period. A memorandum of a meeting in September 1943 (at which Halban was present) mentions that Mackenzie 'now appeared to be avoiding the institution as a whole'.[48] Quite why this should be was not clear, but there was a sense both that the US seemed to have cooled on the idea of co-operation, and that Mackenzie's original (positive) attitude towards the UK team had changed. Disputes over personnel appointments furthered the rift, as did the apparent inflexibility of the NRC in matters of supply. Myriad minor disputes around salaries and working conditions, in which there were significant discrepancies between British and Canadian norms, cannot have helped.[49] The result was a situation of 'interruption by Mackenzie' and 'considerable acrimony' overall.[50]

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[43] *cf.* Chartrand *et al*, who note that Pierre Demers was *'un des rares Canadiens français de l'équipe',* in *Histoire des Sciences au Québec. De la Nouvelle-France à nos jours* (Montréal: Boréal, 2008), p.445
[44] Guy Hartcup and T.E. Allibone, *Cockcroft and the Atom* (Bristol: Adam Hilger, 1984), p.125
[45] Avery, *The Science of War*, p.202
[46] Quoted in Avery, *The Science of War*, p.185
[47] Halban Diary, 29th September 1943, AB 1/570 (TNA)
[48] 'Memorandum of conversation between Secretary, Blok and Halban', 12th September 1943, AB 1/379 (TNA)
[49] See *e.g.* Akers to Appleton, 4th November 1943, AB 1/276; Meeting re. salaries, 27th October 1943, AB 1/276 (TNA)
[50] 'Memorandum of conversation between Secretary, Blok and Halban', 12th September 1943, AB 1/379 (TNA)

A dispassionate attempt at a reasonable interpretation of the leadership travails of the Montreal Laboratory might therefore run as follows: Halban, convinced of the importance of his work, and frustrated by long delays, kept pressing for more resources, for deliveries to be expedited, and for administrative hurdles to be minimised or removed. Mackenzie, hard-pressed for resources and sympathetic to American scepticism about Halban, Montreal, and the British scheme in general, reacted poorly to demands for special treatment. Minor grudges and incompatibilities compounded until the situation had become almost irrecoverable. It was unfortunate, but perhaps inevitable, that such a breakdown had coincided with the crucial stage in negotiations. Had the Montreal laboratory been a purely bilateral affair between Britain and Canada, its problems might yet have been easily solved, but it was not: its fate was now bound up in the vexed issue of Anglo-American co-operation. Halban had had the impression for some months that some of the senior Americans objected personally to him, and by April he had at last extracted from Chadwick an acknowledgement that this may, indeed, have been the case. Between them they sought to account for it, and could derive only two hypotheses: either 'some influence of Mackenzie' on the Americans had been at work, with Mackenzie having perhaps elaborated, in partisan fashion, on the recent difficulties between them, or else – less plausibly – that somehow they were displeased by the 'publicity' (a relative term) accorded to his earlier Cambridge work.[51] Akers at least, thought the Mackenzie theory 'quite possibly well founded', but was unconcerned about its long-term impact:

> I do not think, however, that this effect is likely to last because I do not believe that people can have much to do with Mackenzie without soon realising that he is certainly not a big man nor is he particularly reliable. [52]

(Note, again, the personal animus which Mackenzie seems to have inspired in some quarters of the British team, recalling that this was not the first such instance of disparaging marks about his competence). Little could be done, though, to ameliorate whatever deficiencies he may have had in British eyes: at such a crucial juncture it would not have been wise to have precipitated a breach with the Canadians on a point of principle. Questions of fairness, blame and responsibility mattered little in the final analysis. Halban was part of the problem, and he knew it. The inclination of some of his colleagues (chiefly Chadwick) to fight his corner was personally gratifying, but more was at stake now than principle. Halban thus wryly noted that 'injustices to individuals have sometimes to occur in war time',[53] and stoically accepted the necessity of his own replacement.

The question thus arose: to whom should the laboratory now be entrusted? Allen Shenstone, a Canadian, had been mooted in the earlier conversations about the desirability of appointing an administrative director,[54] but the role to be filled was now several grades senior, with responsibility for scientific direction and – assuming negotiations were successful – the project to develop nuclear piles. It was doubtful that any Canadian scientist had the requisite stature in nuclear physics, and anyway part of the purpose now was to convey to the Americans the extent of British seriousness about large-scale work. The candidate must therefore be a British scientist of considerable international standing. The obvious candidate was John

[51] Halban to Akers, 14th April 1944, AB 1/379 (TNA)
[52] Akers to Halban, 26th April 1944, AB 1/129 (TNA)
[53] Halban to Akers, 14th April 1944, AB 1/379 (TNA)
[54] 'Memorandum of conversation between Secretary, Blok and Halban', 12th September 1943, AB 1/379 (TNA)

Cockcroft, in whom converged solutions to the practical and diplomatic challenges posed by Montreal. He was British. Having 'split the atom', he had ample scientific cachet. Although currently focused on radar work, he had had a hand in the MAUD Committee's work. His appointment would help banish the lingering perception, in American and Canadian eyes, that Montreal was an after-thought, nothing more than Halban's heavy water sideshow. More than that, his appointment could serve as the very mechanism by which the Americans could be persuaded to engage seriously with the work at Montreal. Cockcroft visited Montreal just before Christmas 1943,[55] and it seemed that he could be persuaded to accept the role as its director.

All depended, however, on the sort of work the laboratory would be permitted to conduct. Cockcroft made clear that his acceptance would depend on Montreal's taking a 'proper share' in heavy water pile development.[56] This introduced a degree of circularity in the discussions. Cockcroft could only be expected to lead the Montreal work if its new programme of work was to be sufficiently substantive; the Americans would only give their support for a substantive programme if Cockcroft – or someone very much like him, and very much *un*like Halban – were appointed. There were, moreover, complications. If Tube Alloys wanted Cockcroft, they would have to fight for him. He would have to be released from his Admiralty work, and from his employment by Cambridge; in both cases, a process of mediation, complicated by the inevitable vagueness produced by conflicting secrecy edicts, was required. The loss of Cockcroft would be a blow to the radar work, but it would have been difficult for the Admiralty to have made a case that their programme, now reaching maturity, had greater need of Cockcroft's expertise than a project for which he was uniquely qualified and to which he had been called not simply by the British government, but by two key allies. In fact, pulling him from radar work at this stage made strategic sense: although the ultimate impact on the British radar programme would be low, the ostensibly sacrificial redeployment of a senior scientist from another secret project would convey precisely the right message of earnestness to the Americans and Canadians. Severing the Cavendish connection was more emotionally fraught. Lawrence Bragg, at Cambridge, was resistant to the idea that he might lose one of the few remaining stars in the Cavendish's waning firmament, and as negotiations around Montreal continued into 1944 he would continue to clutch at any sign of wavering in Cockcroft (of which, given the fluctuations in the wider negotiations, there were a few) to argue that he should not go. There was never much hope for Bragg; his argument that 'the Cavendish is too important to sacrifice entirely to the war effort', was superficially compelling, but paled against the cacophony of voices calling for Cockcroft and the seemingly inexorable demands of the nuclear programme as a whole.[57] There is a sense in which the Cavendish *was* sacrificed to the war effort, with Cockcroft one of the last on the altar.

The strange centrality Cockcroft's appointment assumed in the post-Quebec negotiations for Montreal is instructive in several senses. Personality mattered; that much is clear. A history of the Anglo-Canadian project which spoke only of impersonal diplomatic imperatives in tension, as though of plate tectonics, would be incomplete. In reality, personality clashes intersected awkwardly with questions of high politics, and the incompatibilities of individual characters came to be interpreted through the lens of nuclear

[55] Akers to Perrin, 24th December 1943, AB 1/277 (TNA)
[56] Ibid.
[57] Bragg to Appleton, 26th December 1943, AB 1/276 (TNA)

diplomacy. There is a temptation also to over-compensate, and to see in these questions of leadership the project in microcosm: the Canadian Mackenzie torn between British and American expectations, favouring the latter but still dependent on the former, taking against a mode of collaboration that had almost been forced on him, compelling the British to offer, in Cockcroft, a compromise option. That would, however, be too neat, too literary. Academic history can admit analogy, but nothing more. All that the leadership question actually offers the historian is an insight into certain Anglo-Canadian-American dynamics, and a salutary reminder that individual character and individual choices can shape events. The transition from Halban to Cockcroft was as much about the shifting attitudes of the British and Canadians as it was about personal aptitude. Montreal under Halban had been speculative: part insurance policy, part mechanism for leveraging the Americans. The context had now changed. Under Cockcroft, Montreal had hope of a purpose and a programme for itself, but also represented the hope of a reconciliation of British, American and Canadian perspectives.

Rethinking Collaboration

Securing Cockcroft for Montreal was necessary for the negotiations to progress, but not sufficient to conclude them satisfactorily. Beneath the politics of personality lay more essential tensions which had not yet been resolved. There was much rumination in London, as there had been in the face of earlier impasses, and under Anderson's leadership a policy of caution seemed set to hold. Akers thought that perhaps his superior's diffidence around the Montreal negotiations stemmed from a fear that too forceful an approach (*i.e.* the presentation of an ultimatum) might somehow impede collaboration on other aspects of the project. Akers, in a slight departure from his earlier adherence to the 'acceptance' policy, dissented from such an analysis, believing that 'the Americans in general do not object to having a bluff called'.[58] If that were so, perhaps now a more assertive approach might actually work. This idea resonated with two unanswered questions about British nuclear policy: what would happen to the Montreal Laboratory if no programme could be agreed? and what should be done about the elements of the British programme which had not been incorporated into the American? As the Americans continued to prevaricate and delay, an idea which had previously been avoided came once more, through desperation, to be considered seriously. With the post-Quebec naïvety having by now completely evaporated, the British considered abandoning the Canadian work altogether and refocusing on the idea of a wholly British programme.

The idea of revivifying the work in Britain was born of frustration and an acute sense that Montreal's awkwardly inactive existence was untenable. There was little in the British heavy water proposal to appeal to the Americans, and if no progress should be made a minute from January 1944 foresaw a retreat to the UK as a likely, if undesirable, outcome:

> If it should be that the United States authorities continue to "hedge" or to say definitely that the Canadian team cannot have the necessary priorities, it seems very likely that the only thing to do will be to bring the entire Canadian team back to Britain.[59]

[58] Akers to Gorell Barnes, 21st March 1944, AB 1/113 (TNA)
[59] Minute, 3rd January 1944, AB 1/277 (TNA)

The essential problem was that the Canadian work required American support to be viable. American policymakers, though, paid scant regard – indeed, were often inimical – to British interests. Montreal's survival was therefore predicated on the ability of the British to persuade the Americans that a bolstered programme in Canada served American interests. This was by no means straightforward, for in 1944 the Americans seemed inclined to argue that there was no inherent merit in heavy water over graphite, with which they had already made great progress. If graphite could secure all the gains of heavy water, in a shorter timeframe, it was 'entirely logical' for the Americans to disregard heavy water as a wartime project. What was logical to the Americans was not so to the British. They, lacking the Americans' graphite pile experience, saw the heavy water work as their only route to an understanding of plutonium production. In Akers' view the one consolation of an American rejection of the Montreal heavy water programme would be that such a clear-cut decision would simplify things enormously for the British. If his assessment of the situation were correct, the Canadians 'would not want to express any opinion':

> Obviously they would not wish to continue to devote any substantial effort to a joint programme with us, in Montreal, in the face of the American attitude, so that the Montreal Laboratory would automatically close down. This would enable us to bring back to England all those members of the Montreal team who are willing to come to this country. [60]

The stakes were therefore strikingly high. If the Americans should argue in the CPC that heavy water piles could not be considered a war priority, the effect 'would be to remove any reason for the joint Anglo-Canadian Montreal venture'.[61] Akers was 'certain that the Canadians will not join in any really active effort which is not supported by the Americans'.[62] There would therefore be no choice but to admit defeat and return to the United Kingdom. They would have lost about 18 months, but Akers' conscience at least would be clear:

> If we have to take this drastic action we shall still not feel that we were wrong to send this team to Canada in the first instance because, at the time we took this decision, we had clear promises from the Americans of full co-operation.[63]

An assessment was made in mid-March which, after rehearsing the basic situation – that the Americans were not building a heavy water plant themselves and had not decided on whether to co-operate with the UK and Canada, despite also accumulating heavy water supplies – returned to core principles. British T.A. policy in the previous two-and-a-half years could be described as resting on two premises: that it was 'not justifiable to divert from the immediate war effort… for the design and building of large-scale plants in this country' if such plants were also being built jointly in the United States, and that Britain's 'considerable contribution' would be merged with the American for the duration of the war 'with the certainty that the

[60] Akers to Chadwick, 1st March 1944, AB 1/376 (TNA)
[61] Akers to Munro, 8th March 1944, AB 1/379 (TNA)
[62] Ibid.
[63] Ibid.

post-war development and use, both militarily and industrially… would be handled by the two countries on the basis of complete co-operation'.[64]

Anderson was also worried that an apparently satisfactory American proposal might 'turn out to be illusory and lead only to delays which would complete the moral disintegration of our Montreal team'; in which case he would have preferred to have the team recalled to work on something in the UK instead.[65] Perrin, too, was concerned that the Montreal team could not be held together without an adequate programme of work; any 'half-hearted' programme in Canada would be a waste of time.[66] Why, after all, should the Americans support another, less rapid, less proven method, over which they must have less control? It could only ever be 'reinsurance' for their electromagnetic and graphite pile processes, and a useful, but by no means vital, source of information on a possible future line of enquiry.[67]

It had by now become abundantly clear that relations with the United States were 'neither as simple nor as complete' as had been hoped. Reappraisal and re-formation of policy were therefore urgently required.[68] The starting point had to be the American programme – primarily focused on achieving the quickest possible development, but with 'serious consideration' given also to the longer-term implications; Groves *et al* had said that their policy was to have 'exclusive control' over both the weapon and essential supplies.[69] British support on the EM and diffusion plants, and on fundamental physics and ordnance issues, would allow the UK to 'acquire a detailed knowledge', but this accrual of experience alone would not suffice: a policy was now required for the longer-term interests of the UK nuclear project as distinct from the allied/American-led effort. The British, though, were almost entirely ignorant of American plutonium work: they knew only that they had been kept apart from the main centres of research, and could rely only on the gleanings of gossip. Yet present knowledge suggested very clearly that plutonium would be the preferable form of fissile material, rather than uranium-235, which had utility primarily as a wartime 'short-cut' to a weapon. Britain therefore needed a plausible 94 pathway of its own. Tube Alloys. as a whole was something 'this country cannot afford to neglect or only to take a mild scientific interest in'.[70]

The plan should therefore be

> [to provide] the maximum possible help to the Americans in their efforts to develop a military weapon during the war; to provide our specialists with full knowledge of the design and operation of the American plants for the separation of U.235 and to carry out, in the U.K., a research and development programme leading up to the building of a large-scale plant for the production of 94 as quickly as possible.[71]

[64] 'American position: its effect on U.K. Policy and Programme', 15th March 1944, AB 1/644 (TNA)
[65] Anderson to Dill, 15th March 1944, AB 1/113 (TNA)
[66] Perrin to Gorell Barnes, 15th March 1944, AB 1/113 (TNA)
[67] Anderson to Dill, 15th March 1944, AB 1/113 (TNA)
[68] 'American position: its effect on U.K. Policy and Programme', 15th March 1944, AB 1/644 (TNA)
[69] Ibid.
[70] Ibid.
[71] Ibid.

From this flowed two implications. First, an adequate supply of uranium was required. This would have to come 'either by allocation from joint British-American controlled production' – not necessarily a reliable source, given the vagaries of American co-operation and the occasionally obstreperous attitude of US officials – or else from 'sources developed in the British Commonwealth for which British preference could be secured'.[72] This second option was inherently appealing, and more shall be said on the matter in subsequent chapters. The second implication was that Britain must, at all costs, make progress on 94. Thus, 'If full co-operation with the Americans on the building of a large-scale plant in Canada is not obtained the Montreal team should be recalled and intensive work should be started here'.[73]

The idea of an ultimatum was broached: if the Americans could not commit within two weeks, Britain must assume that the Americans were not interested in collaboration.[74] The CPC might, quite reasonably, conclude that a full-scale heavy water plant could not be treated as a wartime project. In that case, Tube Alloys could either bring the British sections home, along with 'as many good Canadian scientists as would come' and aim for a large-scale effort at home; or else 'allow the team to break up and individual members to enter the American teams or to take other war work' (a course which the Americans would not be likely to approve). At any rate, the situation could not be allowed to continue: Halban's cables were by this point making clear that the Montreal team, 'desperate at the delay', had come to the point of disintegration.[75] British analyses began to be tinged with paranoia. On 20th March, Akers wrote to Halban that 'Protraction of discussions with Americans on large scale programme in Canada appears unreasonable and may well be deliberate in order to prevent your organisation and this country starting useful work'.[76] Anderson meanwhile was drawing towards the view that unless the Americans were willing to commit wholeheartedly to large-scale work in Canada 'he would prefer, in the national interest, to face the difficulties in carrying out the work here [in Britain]'.[77]

Akers and his colleagues therefore began to consider what might in fact be involved in such a move. Might the Americans be willing to collaborate with a programme based in the United Kingdom? It seemed unlikely, and perhaps undesirable. Anderson ordered Dill 'not to take the initiative in suggesting American collaboration in any large-scale development [in the U.K.]'. Yet if on the other hand the United States should 'suggest such collaboration, I am quite ready to agree to it provided that fully reciprocal arrangements are made as regards the work on element 94 being carried out in the US'.[78]

This is not to say that the British had wholly committed to forsaking Canada. Thoughts of repatriation were entertained in parallel with earnest endeavours to secure a future for Montreal. Enthusiasm for repatriation was most enthusiastic when the prospects of such a future seemed worst. March 1944 was a low ebb, Anderson confessing 'I do not think that we can expect to get top priority for the Montreal project'.[79] There was, however, a lingering hope: a lesser priority, equivalent to some of the lower-priority pathways within

[72] 'American position: its effect on U.K. Policy and Programme', 15th March 1944, AB 1/644 (TNA)
[73] Ibid.
[74] Draft cable to Dill, 20th March 1944, AB 1/113 (TNA)
[75] Akers to Anderson 20th March 1944, AB 1/113 (TNA)
[76] Akers to Halban, 20th March 1944, AB 1/113 (TNA)
[77] Ibid.
[78] Anderson to Dill, 23rd March 1944, AB 1/113 (TNA)
[79] Dill to Anderson, 20th March 1944, AB 1/113 (TNA)

the American project, might still be achievable. Whether or not it would be desirable was another matter, for this might still constitute the 'half-hearted acquiescence' which Anderson feared.

> Unless the Americans clearly do not want to give any support to the Montreal project it will be difficult to tell them that we are going to set up on our own in England – and still keep up their co-operation which we now have so fully.[80]

After many months of seemingly fruitless discussion, there was great appeal in the idea of spiting the Americans altogether and striking out with an alternative programme, unbeholden to the stifling restrictions of Groves and company. Anderson wrote to Dill on 22nd March 1944, giving the perspective from London:

> Our position is as follows: We believe that the simplest and most effective way of producing the military weapon will eventually be by the use of element 94 either as such or indirectly rather than of U235; and to the extent that power generation is of possible importance for military as well as other purposes 94 would certainly be preferable. We also believe that the best way of producing element 94 on a large scale is through a heavy water pile. We also feel that we have a moral obligation to the Montreal team which was recruited on the express understanding that they were to work on a project to which the very highest importance was attached.
>
> We are, therefore, determined that the programmes for which we are either solely or jointly responsible must include, as an item of the highest priority, really active and large scale development of heavy water pile.
>
> We have, hitherto, urged that this development should be undertaken as a joint enterprise in Canada. We still think that, given American goodwill and the highest priorities, this would be the best course. If however, we cannot be completely satisfied that these will be forthcoming, we are bound to conclude that it is only by bringing the Montreal team back and starting on large scale developments with the highest priorities here that we can achieve our object and make the best use of the Montreal team[81]

Anderson understood that the Americans, having resolved a pathway to 94 production, might reasonably be reluctant to give priority for a project which would essentially duplicate that effort (and proceed more slowly), but still felt it reasonable to hope for 'the same kind of collaboration as we have been giving them on U 235'. They would not be beholden to American preferences: 'In the last resort we must exercise our right to carry out in this country any work we consider it essential in the national interest to undertake'.[82] An earlier draft of this message was even more combatively phrased: unless the British representatives were 'entirely satisfied' that a tripartite project would be 'at least as effective as anything we could do here',

[80] Dill to Anderson, 20th March 1944, AB 1/113 (TNA)
[81] Anderson to Dill, 22nd March 1944, AB 1/113 (TNA)
[82] Ibid.

there would be 'no option but to recall our Montreal team and start here'.[83] The same day, Anderson cabled instructions to the British High Commissioner in Ottawa, asking him to

> personally visit Montreal and assure Halban and senior members of his team that it is our policy that a large scale heavy water project should be carried out in this country unless we are satisfied with American proposals for co-operation in Canada. [84]

The High Commissioner did so on 28th March. For the long-embattled Halban and his jaded colleagues, there was reassurance in the High Commissioner's words. 'Everybody', Halban reported, 'was considerably encouraged by the attitude taken by the U.K. Government, and cheered up by conversation with the High Commissioner.[85] He also sensed a hope amongst many of his colleagues

> that the United States will say no and that we will put up an organization in England. Whilst I am in my heart in agreement with those who think so, I do not think it a very reasonable attitude in view of the time schedule. I still hope that we get either a large scale project started here or at least a loan of a substantial quantity of Heavy Water which will keep us going until British Production starts[86]

This hope prompted Halban to think seriously about how he and his team could approach the practical problems of a move back to England – something he had, it would appear, been pondering for a while. He was chiefly concerned to avoid the earlier experience in Montreal of having arrived without a pre-prepared laboratory, having to share space with another institution. He took a somewhat roseate view of the prospects of a continuing relationship with the Americans: 'if the shifting to England is done without a complete break in relations with the States we might be able to get quite a lot of information' – though this would require a residual presence in North America to be maintained. There would also be challenges to be faced with the transport of equipment, and there was likely to be some considerable difficulty in bringing Canadian personnel over to the United Kingdom. ('There are certainly some Canadian scientists whom we should like to have with us if they should be willing to come'). Plans, indeed, had been lain for such an eventuality: 'The High Commissioner mentioned that the Chancellor has forwarded for such an eventuality an invitation to Mackenzie to send some of his people'.[87]

Halban also foresaw further awkwardness around the Free French, and – most serious from the point of view of morale – likely issues with the transportation of personnel and dependents back to the United Kingdom. In all but exceptional cases, it seemed likely that the families of staff could not actually expect to be allowed to return: the priorities for travel simply would not be forthcoming. All the administrative wrangling that had been required to unite families in Canada would thus have proven counter-productive.[88] Whether such realities had dawned on the faction at Montreal advocating for a return to Britain is unclear, though it seems unlikely. Nor did such logistical challenges carry undue weight amongst the British

[83] Draft cable Anderson to Dill, 22nd March 1944, AB 1/113 (TNA)
[84] Anderson to MacDonald, 22nd March 1944, AB 1/113 (TNA)
[85] Halban to Akers, 30th March 1944, AB 1/277 (TNA)
[86] Ibid.
[87] Ibid.
[88] Ibid.

decision-makers. Morale mattered, of course, and the deft handling of temperamental scientists was fast becoming the chief métier of the Tube Alloys administrative staff, but the discomfort of individuals counted for little when weighed against paradigm-shifting significance of the nuclear project. Whether the British were to abandon Montreal, or commit ever more fully, it would be for reasons of high strategy rather than majority sentiment or personal preference.

The Canadians were of course unlikely to be particularly happy about this new policy, especially given their significant commitment of resources to date, but the British must nevertheless try to persuade them. In this, they would make a virtue of supposed necessity, arguing, first, that it 'would clearly be infinitely easier to do the work here' than to ship necessary materials to Canada from Britain. Second, there was a financial inducement: 'our exchange position is such that we could not carry our fair share of the financial burden' of an Anglo-Canadian programme in Canada (and therefore denominated in dollars). Last, there would be efforts at mollification:

> If it is eventually decided to carry out the project here, we would, of course, welcome the maximum co-operation which the Canadians as well as the Americans could afford by inclusion in the team of any Canadian or American scientists who could be spared and by the exchange of information.[89]

Not much solace for the Canadians, perhaps, but it might be better than nothing. The Canadians, true to type, continued to hope for an agreement. As Holmes put it:

> The Canadians' hopes and expectations were constantly frustrated by the compromises the great powers exacted of each other and of them, but they tried not to forget that great-power agreement was the *sine qua non* of any order in which Canada could flourish.[90]

Privately, though Mackenzie was beginning to doubt what the future might hold. The whole Canadian programme seemed still to be in the balance: 'As far as we are concerned whether or not the work proceeds in Montreal will depend entirely upon the outcome of the pending negotiations. We will either go forward on a real scale or cut down to a token effort only'.[91]

Neither transpired. The subcommittee instead recommended a compromise option: construction of a smaller-scale pilot plant. This was less than the British had hoped, but still held some appeal. Acceptance of a pilot plant at Montreal would make immediate use of the Montreal team in an application which would suit British post-war development plans, but whereas repatriation might well scupper all other forms of collaboration – including the valuable work at Los Alamos and Berkeley – this approach would satisfy American scruples about Britain's relative priorities.[92]

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[89] Anderson to MacDonald, 22nd March 1944, AB 1/113 (TNA)
[90] Holmes, *The Shaping of Peace*, p.x
[91] Mackenzie to Goodeve, 25th March 1944, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[92] Dill & Campbell to Anderson, 8th April 1944, AB 1/113 (TNA)

The subcommittee's recommendations were unanimously adopted by the CPC on 13th April 1944.[93] No time was lost by Howe in requesting Cockcroft's release,[94] which Anderson swiftly arranged, simultaneously promising to reinforce Montreal with additional British scientific personnel.[95] Halban initially felt the compromise plan 'a big disappointment' – as indeed it was, in comparison with early hopes.[96] In context, though, the Americans' acquiescence in granting the Anglo-Canadian project a future seemed a triumph. With the CPC united, there was, Appleton told Chadwick, 'no difficulty at all' in getting the proposals agreed in London: 'I think we have got as much as we could reasonably expect and certainly much more than I anticipated'.[97] The Canadians, too, were contented. Mackenzie, recommending that Howe cast Canada's vote in favour of the proposal, had stated his view that

> Canada has a unique opportunity to become intimately associated in a project which is not only of the greatest immediate military importance, but which may revolutionize the future world in the same degree as did the invention of the steam engine and the discovery of electricity. It is an opportunity Canada as a nation cannot afford to turn down.[98]

The desperate expedient of a return to the United Kingdom had been averted. That it had been considered at all is a measure of how vital plutonium production had become to British interests.

The Triangular Relationship in Practice

Montreal had a future, at last. The details of interchange and the extent of American engagement would have to await the change of leadership,[99] but Cockcroft was on his way, and there was every reason to expect rapid advances.[100] Although there was some reason to be disappointed with the promise only of a pilot plant,[101] the team would be at least be 'properly occupied'.[102] Reports began flooding in that Howe and Mackenzie had suddenly become enthusiastically engaged with the problem of finding a site for the pilot plant,[103] and indeed the difficulty now was to persuade the former that it would not be possible to "pour out concrete on Thursday next".[104] This exuberance extended to a professed willingness that Canada should shoulder the full cost (though this need not preclude British contributions).[105] By the start of May Cockcroft had arrived in Canada – after a swift trip on an American Douglas transport aircraft, no less – and leapt straight into action. Within a week he had visited a possible site with Groves and Mackenzie, drafted a policy on exchange with Chicago, resolved a range of administrative difficulties with Mackenzie,

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[93] CPC Minutes, 13th April 1944, *Documents on Canadian External Relations* (Canadian Department of External Affairs; *hereafter DCER*), Doc.596
[94] Howe to Anderson, 14th April 1944, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[95] Anderson to Howe, 19th April 1944, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[96] Akers, 14th April 1944, AB 1/164 (TNA)
[97] Appleton to Chadwick, 25th April 1944, AB 1/566 (TNA)
[98] Mackenzie to Howe, 10th April 1944, DCER Doc.594
[99] Halban to Akers, 21st April 1944, AB 1/379 (TNA)
[100] MacDonald to DO, 27th April 1944, AB 1/541 (TNA)
[101] Halban to Akers, 14th April 1944, AB 1/164 (TNA)
[102] Dill & Campbell to Anderson, 14th April 1944, AB 1/113 (TNA)
[103] Halban to Akers, 16th April 1944, AB 1/113 and *cf.* Chadwick to Akers, [17th] April 1944, AB 1/113 (TNA); Halban to Akers, 16th April 1944, AB 1/113 (TNA)
[104] Halban to Akers, 21st April 1944, AB 1/379 (TNA)
[105] Dill & Campbell to Anderson, 14th April 1944, AB 1/113 (TNA)

and pledged to 'help build up the Chemistry Division from Canadian stock'.[106] Progress from this point on was rapid. At its new home at Chalk River, the Anglo-Canadian team designed and constructed two reactors, ZEEP and NRX. On 5th September 1945 ZEEP became the first operational nuclear reactor outside the United States; the whole process had taken less than 15 months.

The problems of site selection, reactor design and construction were chiefly technical, rather than political, and therefore need not be dwelt upon here.[107] Instead, it would be well to consider the final tripartite arrangement in more detail. One immediate consequence of the resolution of the heavy water question was that the idea of a substantive wartime programme in the United Kingdom was at last laid to rest. On taking up his directorship, Cockcroft expected to arrange with Chadwick 'the allocation of remaining U.K. personnel to projects over here' (that is, in Canada),[108] and for a time it seemed possible that there would cease to be any active work in Britain. Some work did in fact continue in a handful of locations, but this was (relatively) small in scale and scant in significance, amounting to little more than a vestigial outworking of the research programme instigated by MAUD

The awkward triangular relationship had passed through several iterations, and at times were held together only by 'the common goal and the common fear', as Holmes put it.[109] Now, though, they had achieved a form of equilibrium. For the British the focus shifted from the diplomatic to the practical, motivated in part by a sense that they must now justify their hard-fought inclusion.[110] There was, however, no doubt about the hierarchy implied by the CPC structure. The price of inclusion was junior partnership. Chadwick appreciated better than anyone the extent to which the British achievement must be tempered by humility in the face of the Americans' drive for the bomb:

> I am convinced that [the agreement] is the best that can be got and also that it is quite satisfactory from a purely British point of view. It gives us the opportunity of investigating heavy water systems on a reasonable scale and within a reasonable time…. On the other hand, if demands from Montreal were to clash with requirements for the other U.S. projects we must expect Montreal to take second place, for it is not and cannot be a war project.[111]

This subordination to the Americans played out in several ways. Most notably, there was still great sensitivity, verging on fear, as to how the Americans might interpret any action on the part of the United Kingdom. For example, the natural desire to bring together senior British personnel from each of the teams in North America for a meeting in Canada to coordinate next steps was hindered by a concern that such an action might be misconstrued by American observers. Chadwick worried that 'that a meeting in Canada might cause some misgivings in United States minds'.[112] Chadwick spoke from experience. It was he who had had to allay American suspicions aroused by the seemingly indecent haste with which the British had sought to act after the Quebec Agreement; knowing Groves, he could well imagine how an all-hands

[106] Cockcroft to Appleton, 8th May 1944, AB 1/278 (TNA)
[107] The best treatment is, predictably, in Gowing, *Britain and Atomic Energy*.
[108] Cockcroft to Appleton, 8th May 1944, AB 1/278 (TNA)
[109] Holmes, *The Shaping of Peace*, p.203
[110] Anderson to MacDonald, 18th April 1944, AB 1/113 (TNA)
[111] Chadwick to Akers, [17th] April 1944, AB 1/113 (TNA)
[112] Chadwick to Anderson, 26th April 1944, AB 1/113 (TNA)

colloquium of British interests, held outside the United States, with no American voice present, might be viewed. Groves had conceded much: it would best not to give him undue cause to regret his munificence.

An additional consequence of the new equilibrium was a united effort to resolve the previously vexed question of uranium supply. This took the form of the 'Declaration of Trust', conceived by the CPC as a vehicle for the effective and equitable distribution of global uranium supplies, in the wider context of the overriding need to prevent the material from falling into the wrong hands. It had been relatively painless to draft. It was proposed that each government would take responsibility for controlling uranium ores 'in the territories under their respective control' and that the United Kingdom would additionally 'approach the Governments of the Dominions (other than Canada) and of India' to ensure that those governments would take similar steps.[113] The trust would act corporately to gain control for all other territories. Uranium and any other materials obtained by this mechanism would be held in trust 'for the three Governments jointly and disposed of or otherwise dealt with in accordance with the directions of the three Governments'.[114] The six trustees would reflect the same three-two-one composition of the CPC.

Churchill had readily signed off the first draft of the declaration, and when a slightly altered version came back to him from the Americans there seemed nothing with which to take issue. Only two substantive changes were introduced. The first – that the CPC would appoint the trustees, rather than the national leaders, was palatable enough. The second, though, was that the agreement was now to be only bipartite. Canada, originally intended to be a party to the agreement, would not now act as signatory, though it remained the intention that one Canadian be named as a trustee. This was not deliberate exclusion by the British ('We have of course no reasons of a political nature for wishing to exclude Canada from participation as a signatory in the Declaration of Trust'),[115] and the Canadians in fact favoured this arrangement.[116] Howe, indeed, 'expressed strong preference for it', arguing that it was ' more logical and practicable' in light of the equally bipartite Quebec Agreement and, in practical terms, for the conduct of uranium supply negotiations with other Governments, such as those ongoing with the Belgians.[117] This all made sense. The negotiations with the Belgians were delicate, and the addition of another party – particularly a mid-level power like Canada – would likely alter the dynamic of negotiations unhelpfully. A final, bipartite formulation was therefore agreed,[118] with the British undertaking simply to 'approach the Governments of the Dominions and the Governments of India and of Burma'.[119]

These revisions conveyed the idea that Canadian participation was predicated on, or subsidiary to, the British relationship with the United States. Bipartite treaties with a three-two-one representational structure implied the marriage of an American project with a British-led Anglo-Canadian one. Canada was, in a sense, subsumed into a Commonwealth identity, making the CPC representation not unevenly tripartite, but evenly bipartite. At this stage, such an arrangement suited the Canadians perfectly. As Holmes has

[113] Draft of Declaration of Trust, PREM 3/139//2 (TNA)
[114] Ibid.
[115] Anderson to Campbell and Dill, 11th May 1944, AB 1/657
[116] CJM diary, 20th May 1944
[117] Minute to PM re: CDT c. May 1944 (later than 21st May), AB 1/657; MacDonald to Anderson, 20th May 1944, AB 1/657 (TNA)
[118] Gowing, *Britain and Atomic Energy*, Text of Declaration of Trust, p.444
[119] Ibid.

(rightly) noted, what the Canadians essentially, wanted was 'a chance to state their requirements, not the responsibility of the grand decisions'.[120]

The Quebec Agreement, and the agreements over Montreal and uranium which flowed from it, held for the rest of the war. There were no further crises in Anglo-American nuclear relations, and instead a period of industrious stability ensued, whose fruits became public at Hiroshima and Nagasaki. That is not to say that the Anglo-American nuclear relationship was henceforth plain sailing. There were various alarms and excursions associated with the course of the wider war: the liberation of France raised again the question of the Free French physicists, of whose presence the Americans had long been suspicious, and although after Cockcroft's arrival Halban had been honourably side-lined lingering resentment later broke forth in new bitterness.[121] The British remained nervous of American intentions, and kept a wary eye on anything that might disturb the delicate balance of their nuclear relationships, framed as they were partly in Anglo-American and partly in Commonwealth dynamics.

Conclusion: A Tripartite Project?

An appreciation of the trajectory of the Canadian project after Montreal both supports, and adds nuance to, two of the great themes of Canadian historiography – the depiction of Canada as a mediator between Great Britain and the United States, and of Canada maturing into true independence in consequence of the world wars. That the British seriously considered repatriating the Canadian programme certainly demonstrates the limits of the Dominion ideal, but it is nevertheless the case that British engagement with the United States was shaped and influenced by the fact of Canadian partnership with the United Kingdom, and that the post-Quebec development programme at Montreal and Chalk River amounted to a substantial joint endeavour for the three states.

Assessments of the significance of Chalk River have varied, often in line with each historian's particular standpoint. The challenge here, as in all historiography, is not to identify a single dominating factor, but to weigh all of the relevant factors appropriately. Canada was not a trivial sideshow in the allied nuclear programme, but nor was it the main event. Many have been content to portray the Chalk River programme as a relatively minor abutment to the Manhattan Project – an American sop to British sensitivities, granted not so much because of British pressure as because of the United States' overwhelming desire to secure the bomb rendering it politic not to disturb the balance with a key ally. Others have ignored the Canadian programme altogether, likely on the grounds that it contributed little to the wider wartime project and led to no post-war weapons programme (Canada, after all, never developed the bomb).

The historian Andrew Pierre, in contrast, characterised the work in Canada as the 'cornerstone' of Britain's post-war programme, on the grounds that 'British scientists in the United States gained knowledge of the theory and technology. In Canada they acquired experience in running an atomic energy establishment.'[122]

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[120] Holmes, *The Shaping of Peace*, p.201
[121] Peter Parides, 'The Halban Affair and British Atomic Diplomacy at the End of the Second World War', *Diplomacy & Statecraft,* 23:4 (2012)
[122] Andrew J. Pierre, *Nuclear Politics: The British Experience with an Independent Strategic Force, 1939-1970* (London: Oxford University Press, 1972), p.54

This was not quite how it was seen at the time. The sending of personnel to Los Alamos and Berkeley, and the desire for a substantive programme of work for Montreal, were both aimed at the same overall goal: to secure for the United Kingdom an adequate exposure to all wartime nuclear development work in anticipation of a significant post-war programme under some form of British control or influence. The awkward symbiosis of each of the key strands of the British nuclear programme rested on that assumption. This, of course, resulted in the interesting paradox of British policy in this period: the 'virtual extinction' (Akers' phrase) of much of the UK-based TA work, in order to align as closely as possible with the American programme,[123] pursued simultaneously with a plan to repatriate the entire Montreal programme. Only if the United Kingdom had in view a tripartite post-war programme – a nuclear endeavour grounded in transatlantic relations, marrying Commonwealth unity with a strong Anglo-American alliance – can such apparent contradictions make sense.

The reality of tripartite collaboration was consistently less comprehensive than the British had hoped. Had the interactions simply been between Britain and the United States, a straightforwardly hierarchical interaction might have emerged, with a clearer delineation of junior and senior partnership from the outset: the British would have had to have followed either a path of realism and resignation, able to hope for little more than a handful of secondments of personnel into closely-monitored areas of the American project, or else venture on a string of ever more quixotic efforts to secure a British programme in spite of clear American opposition. Canada – the Commonwealth connection – added complexity. The Quebec Agreement had bound Canada into the nuclear alliance in a form which seemed at once to recognise its sovereignty and to portray it as subaltern to the United Kingdom.

This ambiguity was encapsulated in the three-two-one distribution of CPC and CDT positions. This distribution could be construed as a straightforward ranking of the three parties' importance and prestige, or as an equal partnership between the American programme on the one hand and the Anglo-Canadian on the other. If the Canadian representative held the British position, their combined three votes would counterbalance the three votes of the Americans. Canadian deference to British wishes could not, however, be guaranteed; a system predicated on a unified Empire position might at any time transition to a united North American position, four votes against two. This granted the Canadians an effective power of veto. Mackenzie King had had little to do with the design of this system, but he could have every reason to be pleased with it, for it allowed Canada to access the benefits of Empire membership without any risk of losing independence of action. There was always the possibility of tension and miscommunication between Britain and Canada, though, and it would be reasonable to suggest that (on a conceptual level) one consequence of the war was a widening of the Atlantic. Britain would continue to seek to leverage the Anglo-Canadian project for the sake of its wider nuclear policy, but could do so only in the twice-learnt knowledge that such a policy was contingent on Canadian alignment with British objectives. Avery's metaphor of Canada being treated as a pawn in a scientific chess game therefore needs modification,[124] if only to acknowledge that as the game of chess progresses a pawn can so often prove a most vital piece, influencing decisions right across the board. So it was with Canada. There were, moreover, other pieces – other Dominions – in play; it is to these that this thesis must now turn.

[123] Akers to Perrin, 24th January 1944, AB 1/682 (TNA)
[124] Avery, *The Science of War*, p.188

Chapter Five:
The Dominions and Tube Alloys

The previous chapter highlighted the unique position enjoyed by Canada in the western allies' nuclear counsels. Canada lay within the nuclear pale; the other Dominions did not. Yet whilst the Canadian experience shows that in nuclear affairs the Commonwealth was not perceived as an undifferentiated bloc, it is equally clear from the contrasting experiences of Australia and New Zealand that these differences were not so simple as a narrative of inclusion and exclusion might suggest. Both Australia and New Zealand contributed personnel to the UK contingent in America, but through different mechanisms and with different results. The other Dominions, meanwhile, made few appreciable contributions to the work, but were nevertheless accorded a privileged degree of insight and exposure, engaging with Tube Alloys in a way in which the colonial empire, and still less the non-British world, was not permitted.

This chapter is concerned with the interactions of the non-Canadian Dominions with the British Tube Alloys organisation. As such, it acts as a counterpart to the previous chapter, which addressed the Canadian experience. The chapter recounts the corresponding experiences of Australia and New Zealand in their interactions with Tube Alloys, first individually, then in comparative context, with a view to identifying commonalities and accounting for differences. Lastly, the question of resources is considered. Here, the wider empire is in view, in all its constitutional complexity: the approaches adopted by Britain in her dealings with these entities are instructive. Throughout the chapter, an attempt is made to ascertain the extent of reciprocity in these relationships. The historiography of the British empire is often constructed in terms of core-periphery interactions, and it is important to determine whether this pattern holds true for the wartime nuclear interactions.

Even without such a goal, it is clear that the other Dominions' wartime engagement with nuclear issues merit attention. Long before the first nuclear weapon was tested in the *Jornada del Muerto*, the Prime Ministers of Australia, New Zealand and South Africa had been informed by the British of the programmes' existence. They knew of the military and industrial potential of nuclear fission, and the strategic importance of uranium; they knew much about the immense American-led effort to produce the bomb; most significantly, they knew of, and had in effect been recruited into, British plans for a corresponding post-war effort. They were, in short, early inductees into the nuclear world. (Of course, not all of the Dominions were so engaged. Unique constitutional circumstances attached to Éire and Newfoundland, and neither government engaged directly with the United Kingdom nuclear project during the war. They therefore do not figure in this chapter, or even this thesis.)

It is important from the outset to contextualise the Dominions' contributions to the allied nuclear project. The claim here is not that these Dominions' contributions represented coherent programmes on the American, British, or even Canadian scale. The total Australian and New Zealand contribution amounted to fewer than a dozen personnel, whose impact, though valuable, cannot be considered essential or decisive.

The other Dominions, and the colonial empire, contributed even less. What matters though is the significance of the act of contribution in British and Dominion eyes, and the longer-term consequences of the Dominions' nuclear experiences.

Oliphant and the Australians

Much has already been written in this thesis about the early influence of one Australian, Mark Oliphant, on the early trajectory of the British nuclear programme, and in turn on its nascent American counterpart. Of course Oliphant's early impact had little directly to do with his Australian origin, and much to do with his character, capabilities, and context; from the perspective of this thesis, it was sufficient only to note that Oliphant, by birth and education an Australian, was nevertheless treated, conceptually and practically, as unambiguously British. In this chapter however, Oliphant's Australian-ness comes rather more to the fore. An examination of his late-war return to nuclear physics serves as a convenient gateway to a wider examination of Australia's wartime engagement with nuclear research, for Oliphant, as shall be seen, served as a key conduit for the Australian Government's nuclear initiation.

Australia learnt of the nuclear project at a surprisingly early stage. The first revelation seems to have been in August 1941, during Oliphant's trip to the United States, in the course of which he gave the Australian minister in Washington, Richard Casey, an overview of the uranium question. Alice Cawte's assessment that Oliphant's transmission of this information was 'almost certainly unauthorized' is likely correct,[1] though the lack of censure directed at Oliphant for what was in theory a substantial breach of secrecy implies either tacit approval of the act, or complete ignorance of it. Later insouciant references to early interactions may constitute evidence in favour of the former interpretation. Little in fact came of this interaction in the immediate term, for this was the period in which MAUD was winding down and Tube Alloys still taking shape. Moreover, Oliphant had little to do with the early life of the Tube Alloys organisation, his formal responsibility having ended, in effect, with the MAUD Committee. In the absence of a defined British programme there was little with which Australia could engage. The real effect of Oliphant's memo was to have piqued the interest of David Rivett, the head of Australia's Council for Scientific and Industrial Research (CSIR; DSIR's direct counterpart), and to have alerted him to the potential significance of uranium as a resource and Oliphant as an informant.

Further information came later, and again through Oliphant. After his involvement with the MAUD Committee ended Oliphant had continued his radar work at Birmingham, but in February 1942, greatly troubled by the imminent fall of Singapore, he offered his services to the Australian Government. This was an impulsive act, for which even his biographers have struggled fully to account. Shock, and the associated sense of Australia's sudden strategic vulnerability seem to have played a significant part. The route by which Oliphant made his offer – directly to the Prime Minister, through the Australian High Commissioner in London – is indicative of the level of impact he hoped to have. Having obtained release from his Admiralty work, and with the better part of his Birmingham salary to be covered by the Australian

[1] Cawte, *Atomic Australia*, p.2; see Chapter Two for a fuller account

government, he left for Australia on 20th March.[2] His reception, however, proved lukewarm: Australia's peril had been overstated and the radar work was more advanced than Oliphant had initially assumed it would be. The need for his input was minimal. He began the journey back to the United Kingdom on 26th October 1942. It had been, in all, a frustrating and largely fruitless trip.

It is tempting, in retrospect, to read this abortive stint in Australia as a mere interlude between two periods of more significant activity. Oliphant certainly failed in his notional primary purpose of spearheading the Australian radar defence. Yet his trip had two significant consequences in the nuclear field. First, Oliphant had forged personal and institutional links with Australian government science. His relationship with Rivett and the Australian defence science establishment was preserved both by a regular correspondence and by the provision of a retainer of £250, paid by the Australians through their Scientific Liaison Office, and administered, in the UK, via Australia House.[3] Second, Oliphant had had ample time to reinforce, to Rivett and perhaps more widely, his earlier notices about the future significance of uranium. Although he no longer had any formal connection with the British nuclear programme, Oliphant still possessed an enviable knowledge of the state of the research and the likely contours of future organisations on both sides of the Atlantic. The amount of information Oliphant could have passed on was significant, given that the mere fact of there being a plausible route to a uranium fission weapon which the United Kingdom and United States were actively pursuing would have been significant enough in Australian eyes. The implications for Australia were immense. If the nature of warfare was likely to experience imminent, irrevocable change, and if uranium might soon become the ultimate strategic resource, Australia must act.

Back in the UK, Oliphant continued to communicate with Australian officials. Soon after a meeting with Oliphant, the Australian High Commissioner in London, Stanley Bruce, wrote to his Prime Minister, John Curtin, to inform him, elliptically, of developments around Tube Alloys 'which apart from their significance in relation to the war will have profound economic repercussions in the post-war period.' These developments, he related, were too secret to be communicated by telegraph: Curtin should instead consult Rivett for further details. Noting that Australia possessed strategic deposits of the relevant materials, Bruce advocated their safe-guarding before suggesting that Australia should seek to be 'brought in to the picture as to the present position' *and* be 'kept in touch with all future developments.'[4]

By the end of 1943, then, and chiefly by Oliphant's hand, the Australians had learnt much about the British nuclear programme. They were understandably keen to learn more. In November 1943 Akers made reference to Rivett's interest in engaging with the United Kingdom, particularly around the securing of uranium oxide.[5] From this interest flowed a desire for action which coincided with British interest in Australia's uranium resources. The British were instinctively minded to draw the Australians further into their project, but hesitated in light of the evident diplomatic ramifications.[6] As a result, nothing came of these conversations in the immediate term.

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[2] Cockburn and Ellyard, *Oliphant,* pp.90-91
[3] Longair to Oliphant, 11th November 1943, AB 1/481 (TNA); Cockburn and Ellyard, *Oliphant,* p.93
[4] Bruce to Curtin & note, 16th August 1943, *Documents on Australian Foreign Policy, 1937-49* (Canberra: Australian Government Publishing Service; hereafter DAFP), Vol.VI, Doc.258
[5] Akers to Gorell Barnes, 8th November 1943, AB 1/246 (TNA)
[6] Gorell Barnes to Akers, 10th November 1943, AB 1/246 (TNA)

Oliphant, meanwhile, had once again become an important figure in the British programme. His return to England had meant also a return to the nuclear fold – this time more firmly in the upper echelons of the organisation. Oliphant had been despatched to America in the first flurry of post-Quebec activity. The Americans, still perhaps in awe of Oliphant's crusade on behalf of MAUD, had asked for him by name; the discussion was not about *whether* he was wanted, but *where*: at Berkeley for the electromagnetic work, or at Los Alamos to work on the bomb.[7] It was agreed that he would serve at Berkeley first, transferring to Los Alamos after perhaps six months or so.[8]

Oliphant made a significant impression at Berkeley, becoming, by the spring of 1944, 'Lawrence's de facto second in command'.[9] This was, at least initially, an informal deputyship,[10] but the net effect by April 1944 was that 'When Lawrence is away at site X, Oliphant takes charge'.[11] Helping lead the Berkeley team was no sinecure: there were ultimately more than one thousand scientists working on the project there.[12] From Groves' perspective, the particular utility of Oliphant and his colleagues from the British mission, at least initially, was their ability to offer knowledgeable external review of the US enrichment methods at crucial stages in their development. Oliphant, for example, began his stint at Berkeley by familiarising himself with the entirety of the electromagnetic separation project, and sent Groves a full technical appraisal. It was a valuable exercise for Groves: bitter prior experience of war projects meant that Oliphant was more pessimistic on timescales than Lawrence and his team had been, but he was still confident of the underlying principles, and therefore able to endorse the project's overall feasibility.[13] Constructive commentary of this type, coupled with the demonstrable efficacy of his leadership and the capabilities of the team under him, confirmed Oliphant as a significant figure within the electromagnetic enrichment programme. He visited the Americans' vast production facility at Oak Ridge in November 1943, returning frequently throughout 1944, along with flying visits to Washington and the United Kingdom.

Oliphant's position in later 1944 was enviable: he was, after Chadwick, the best informed of the British contingent in the United States. He and his team were not, however, immune to American constraints around secrecy. Cockburn and Ellyard report that the British team were required to borrow books from the library at Berkeley using false names 'to avoid anybody noticing how many of them there were'.[14] (It is not wholly clear how this method – by which Oliphant became 'Michael Oliver' – would have served this purpose). A complaint was also received from Groves' office 'that [Oliphant] had once received a visit in [his] Berkeley office from a British officer in uniform, who is believed to have been a New Zealander'.[15] The identity and motivation of this uniformed antipodean remain obscure, but it is clear that a close watch was kept on the British team's adherence to security regulations. Even so, Oliphant managed to learn substantially more than he was technically entitled to, and may sometimes have shared his knowledge too

[7] Meeting at War Department, 13th September 1943, AB 1/376; Meeting of Technical Committee Montreal, 19th Sept 1943, AB 1/450; Negotiations with the Americans after the Signing of the Quebec Agreement', Chadwick, 24th Sept 1943, AB 1/129 (also AB 1/376) (TNA)
[8] Notes for conversation with Groves and Tolman on 23rd Sept 1943, AB 1/376; Oliphant to Appleton, 5th October 1943, AB 1/246 (TNA)
[9] Cockburn and Ellyard, *Oliphant*, p.118
[10] Cherwell, 'The Tube Alloys Position', c. March 1944, PREM 3/139/2 (TNA)
[11] Chadwick to Akers, [17th] April 1944, AB 1/113 (TNA)
[12] Cockburn and Ellyard, *Oliphant*, p.116
[13] Oliphant to Groves, 27th November 1943, AB 1/690 (TNA)
[14] Cockburn and Ellyard, *Oliphant,* p.120
[15] Webster to Oliphant, 11th March 1944, AB 1/485 (TNA)

widely. An example: Oliphant wrote to Lawrence in February 1944, saying that he had learned from Bohr and Chadwick that the team at Los Alamos was now focussing primarily on the plutonium weapon.[16] Such information, irrelevant to the electromagnetic enrichment programme at Berkeley, ought not to have reached Oliphant, and certainly should not have been passed on by him to Lawrence: this was, in theory, a serious breach of American compartmentalisation.

Incidents of this kind may help explain one of the more curious aspects of Oliphant's time in the United States – that he never transferred to Los Alamos as originally planned. Peierls had relocated there from New York, and many more were assigned directly from Britain. Oliphant, in fact, was comfortably the most senior of Tube Alloys scientists not to have gone, despite being one of the very few requested by Oppenheimer himself. His biographers acknowledge that 'the transfer never eventuated' but venture no explanation as to why that should have been.[17] They also mention his having made a brief 'sojourn' at Los Alamos in this time,[18] though the evidence for this having actually happened is scant. There was perhaps less need for him by the time his work at Berkeley had reached a satisfactory position, the earlier dearth of senior physicists having by that point been amply met. There seems to be no indication in the archives that the question-marks which the Americans would later raise as to his political reliability had yet emerged, but the possibility cannot be entirely discounted: he had certainly ruffled a few feathers by this point. It also seems reasonable, however, to suggest that the same strict enforcement of compartmentalisation which meant that Lawrence was not permitted information from Los Alamos was applied also to his deputy. It was a missed opportunity, perhaps – certainly for the Australians, who would therefore have no insight into the life of Los Alamos; less so for the British, who already had plenty of eyes there; and perhaps, least knowably, for Oppenheimer and his team, for Oliphant was a very capable and imaginative physicist. Even without having reached Los Alamos, though, Oliphant had had a significant impact, and had accumulated a vast store of insight and experience.

Oliphant's impact was not simply in the research he performed and the information he retained, however. He also served a liaison function between Australia and the United States. While at Berkeley, Oliphant kept Rivett informed of the 'amazing vigour' with which the American work was progressing. His reports were a useful counter to Tizard's more sceptical assessment, which the Australians had also heard. Oliphant also received several letters through the Australian liaison office.[19] In December 1943 Rivett used this channel to enquire 'whether any official request may be expected regarding production of certain Australian ores'.[20] Oliphant was hardly the logical point of contact for such a query. If official channels were to be followed, it should have ended up at Tube Alloys headquarters on Great Queen Street, in the hands of Akers or Perrin, or on the Whitehall desk of Anderson or Appleton; in the United States, it ought ordinarily to have come to Chadwick. That it came to Oliphant makes sense only because Oliphant was Australian, and was bound, relationally and formally (recall his £250 retainer) to Rivett and the Australian Government. Not that Oliphant was simply an informant for the Australians. The British used Oliphant, too, as a conduit for

[16] Cockburn and Ellyard, *Oliphant*, p.120
[17] Ibid., p.119
[18] Ibid., *Oliphant,* p.118
[19] Webster to Oliphant, 11th February 1944, AB 1/2 (TNA)
[20] Rivett to 'Scientific Liaison', 24th December 1943, AB 1/604 (TNA)

messages, especially those of a more exploratory nature. Nor was Oliphant content to act only as messenger. It was generally accepted that Oliphant would be consulted on matters relating to Australia,[21] and his words carried weight. As the British discussed Rivett's queries about whether and when Australia could expect a formal approach from the United Kingdom about Tube Alloys, Oliphant felt sufficiently empowered to add his own gloss on Rivett's message, and to interpret the Australian position to his (notional) superiors, going so far as to offer his own policy recommendation.[22]

This Anglo-Australian liaison work was, for the most part, a self-appointed role. Occasionally Oliphant risked exceeding his authority by asking for too much information from the Tube Alloys administration, as a note by Perrin from January 1944 illustrates:

> [Oliphant asked] that I should keep him in touch with what might take place on the question of supplies of oxide, and in particular with any information about Australia. I have not given any of such information to Oliphant… it seems to me that this is a purely policy matter or, insofar as it is technical, one to which Oliphant could not possibly be able to contribute[23]

Here, then, was the limit of British toleration. Oliphant was a useful intermediary, but a line must be drawn at a brazen request for information far outside his purview. There was such a thing as secrecy within the British programme too, and though they may frequently have deprecated compartmentalisation they did at least practice it. This rebuff to Oliphant's curiosity was, however, the exception rather than the rule. His dichotomous position, looking out for both British and Australian interests, persisted until the end of the war, and beyond. Oliphant essentially had two masters: he was fortunate that the demands of the two could, for the most part, be readily reconciled.

Oliphant's influence was unique, but not his situation. There was, in Harrie Massey, another Australian-born physicist sent to Berkeley from Britain. The parallels, indeed, go further: both were ex-Cavendish men; both had led work at Birmingham. Massey, though, is relatively unsung in nuclear history – at least in comparison with Oliphant. He is prominent in the British archives only when Oliphant's absences (at Oak Ridge and elsewhere) placed upon him, as senior member of the British contingent, responsibility for administrative matters concerning that team; he was, in effect, Oliphant's deputy.[24] Unlike Oliphant, though, he appears not to have made any communication with the Australian government about his work. Massey had arrived in the United States late in 1943, and after six weeks had become convinced that the importance of the work outweighed that of his previous endeavours for the Admiralty on mine design, from which he had been wrenched only with difficulty.[25] A week later, he argued for the release of two (British) colleagues, Bates and Gunn, from the same work, on the grounds that their contribution at Berkeley was likely to be 'of much greater national importance'.[26]

[21] Gorell Barnes to Perrin, 29th February 1944, AB 1/113 (TNA)
[22] Akers to Perrin, 7th January 1944, AB 1/537 (TNA)
[23] Perrin to Akers, 12th January 1944, AB 1/608 (TNA)
[24] Webster to Massey, 14th February 1944, AB 1/2 (TNA)
[25] Massey to Appleton, 3rd February 1944, AB 1/481 (TNA)
[26] 'Theoretical work at Berkeley', 9th February 1944, AB 1/687 (TNA)

A third Australian, Eric Burhop, embodied a different experience altogether. Unlike Massey and Oliphant, who had each been drawn into Tube Alloys from their peacetime roles within British academia, Burhop was recruited directly from Australia. Massey had made the request for Burhop even before his departure for the United States. Burhop was a former student of Massey's – each of the men he requested by name had worked with him before – and Massey wanted him now as an assistant. In spite of the administrative novelty of recruiting from outside the United Kingdom, Akers, to whom the request had come, claimed he could foresee no problems.[27] Massey's desire for Burhop seems not to have had any root in Burhop's nationality, only in their shared history. Yet to Oliphant, who also advocated Burhop's recruitment, his Australian-ness was the entire point. Oliphant's communications with Rivett had 'hinted… that he would like an Australian or two to be associated with the work' and in January 1944 he telegrammed to ask specifically for the release of Burhop on the grounds that he could 'advance materially the use of the new weapon'. This, to Rivett, seemed 'a good opportunity to get one of our fellows into a line of work, and amongst a group of people, which will give him wonderful opportunities for activity'.[28] Rather than simply acceding to the British request when it came, Rivett said that whilst Burhop would of course be released if the British so desired, he nevertheless preferred that 'recommendations covering both his transfer and proposals connected with prospecting for ores in Australia should be made to Australia at the highest possible level'.[29] This was an effort at diplomatic legerdemain on Rivett's part. Parcelling together the distinct questions of Burhop's transfer and uranium resources (to which British thinking had lately turned) would make the Australian engagement with Tube Alloys programmatic rather than *ad hoc*. Insisting on a high-level approach – necessarily directed to the Australian Prime Minister, through either the Dominions Office or the Australian High Commissioner in London – would lend it official imprimatur and a greater cachet.

The effort failed. Akers thought it preferable that Burhop be released from Australian service and then engaged by DSIR, rather than having him seconded directly by the Australians;[30] there was to be no parallel exchange about uranium. Burhop duly transferred to Berkeley, and began reporting home, his reports echoing Oliphant's in their enthusiasm. He told Rivett 'There is no doubt of the stupendous implications of the work'. One such implication was the likelihood that the bomb would be used in the war. Burhop went on to stress his own view that 'this project is very important for the future of Australia', and that his presence at Berkeley was therefore 'a golden opportunity to get knowledge of the techniques that, it seems, will prove vital for the future of the country'. Burhop went on to name five other scientists whom it would be in the 'ultimate interests' of Australia to send.[31]

To achieve the placement of additional personnel in the nuclear work, Rivett sought again to leverage his country's natural resources. The British had long had half an eye on the Australian uranium deposits, which their geological researches had indicated as 'the most likely source for rapid expansion of Empire supplies'.[32] Now, post-Quebec, they had embarked upon a concerted effort to identify and secure sources across the empire – hence Rivett's efforts to find out, via Oliphant, whether a formal approach might be

[27] Akers to Gorell Barnes, 8th November 1943, AB 1/246.
[28] Rivett to White, 5th January 1944, *DAFP,* Vol.VII, Doc.4
[29] Nicholls (Australian Scientific Research Liaison Office London) to Appleton, 23rd March 1944, CAB 126/12 (TNA)
[30] Akers to Gorell Barnes, 31st March 1944, CAB 126/12 (TNA)
[31] Burhop to Rivett, 10th June 1944 Extract, *DAFP*, Vol.VII, Doc.192
[32] [Sayers] to Gorell Barnes, 14th June 1944, AB 1/667 (TNA)

forthcoming. It was, but not in the format Rivett might have hoped. Australia was approached in May 1944, concurrently with the other Dominions, in the conducive setting of the Commonwealth Prime Ministers Conference. The request for action on uranium was therefore made first at the highest level, rather than through Rivett. Instead Anderson spoke with Curtin, the Australian Prime Minister, in person, to ask that Australia begin surveying her known deposits.[33]

The survey was duly begun, but the Australian hope of using this asset to obtain access to the wider nuclear project – including Montreal, where they had no personnel – did not fade. In September, Bruce was instructed to approach Anderson, and inform him that 'prospecting of ore fields is in full swing', and in the same conversation to ask whether Australia should send more men 'both to help present teams and also to gain experience for possible application later in this country'.[34] This was presumptuous in itself, and the Australians' case was not aided by their unwelcome suggestion, presented in parallel, that the British option on Australian uranium should be limited to the period of hostilities (the British interest in securing the uranium being inherently long-term).[35] Bruce pressed again in October, still with the goal of somehow getting another Australian into the North American work (Montreal, if he could manage it). This time, he was told that no further physicists were required, and although Anderson was willing to make a vague reference to the idea that there might at some point be call for a chemical engineer, the practical subtext was that the Australians should cease pestering for further access.[36] This certainly was the conclusion Rivett reluctantly drew, for he soon after informed Oliphant that he felt it would be 'inadvisable to attempt to introduce any more Australians into the U.S.A. team'.[37]

How, then, to assess Australia's wartime nuclear experiences? They had learnt much, and learnt it early. In Mark Oliphant they had the unique advantage of both a reliable informant and well-placed advocate. His unsanctioned but for the most part unimpeded efforts to equip Australia for the nuclear future by binding her closer to the British (and thereby the American) programme have no parallel in any other country's experience. Australia was, moreover, custodian of one of the most promising sets of uranium deposits in the world. They had even had advance warning of the likelihood of British interest in the mineral. These were advantages which ought, theoretically, to have given great leverage. Rivett certainly thought so. Alice Cawte's account frames Rivett's negotiations as a 'diplomatic campaign', consisting of 'numerous and at times disingenuous démarches to the scientific establishments of the UK, the USA and Canada'. The returns on this effort, though, were minimal: the release of Burhop (not even on secondment) and an entirely separate, small-scale uranium exploration programme. This was disappointing in its own right, and doubly so compared with what was achieved by New Zealand. As the war drew to a close, it would have been hard for Rivett and his colleagues to avoid the conclusion that they had failed to capitalise on the head-start which their compatriot Oliphant had given them four years previously.

[33] Draft memorandum, 15th June 1944, AB 1/667 (TNA)
[34] PM's dept to Bruce, 8th September 1944, *DAFP,* Vol.VII, Doc.274
[35] Bruce to Curtin, 15th September 1944, *DAFP,* Vol.VII, Doc.284
[36] Bruce to Prime Minister's Department, 12th October 1944, *DAFP,* Vol.VII, Doc.316
[37] Rivett to Oliphant, 25th October 1944, AB 1/214 (TNA)

The New Zealand Connection

New Zealand came later to the nuclear table than Australia, learning officially of the British project only in the spring of 1944 (and unofficially perhaps only a few months earlier). They had had no information prior to this, for there was no figure equivalent to Oliphant through whom it could have passed. There was little in New Zealand's scientific or industrial track record to suggest that it would play any prominent role. Yet in terms of wartime collaboration, theirs was by far the most successful, and by far the most straightforward, of all the Dominions. Whereas the Australians managed only to release Burhop for work at Berkeley, the New Zealand DSIR, under the leadership of Ernest Marsden, were ultimately able to place seven personnel, on secondment terms, at Berkeley and Montreal;[38] the senior officer among them, Charles Watson Munro, soon came to hold a position of real influence within the Canadian branch of Tube Alloys. It is important to reflect on how this came to be.

The earliest nuclear contact between Britain and New Zealand is difficult to date conclusively. The historian Rebecca Priestley, whose monograph *Mad on Radium* is the principal account of New Zealand's nuclear history, places it in the December of 1943. Priestley recounts an anecdote of Oliphant's, recorded some decades later, in which Marsden, head of the New Zealand DSIR, passing through Washington, came across Chadwick, Oliphant and Bohr in the lobby of their hotel.

> Oliphant later recalled they were in their hotel lobby waiting for the elevator when they felt taps on their shoulders and turned to find Marsden in full military uniform. They were taken aback to hear Marsden say, 'I can guess why two nuclear physicists are here!' During the elevator journey Marsden put in a good word for New Zealand's participation in the bomb project. He followed this up in London with Sir John Anderson…[39]

How much weight should be given to such an anecdote? In the face of such neat, seemingly fortuitous incidents the historian's natural tendency is to scepticism: in telling their own stories humans are apt to substitute a pithy vignette for the convolutions of lived experience, and in an anecdote a potentially fabricated part may stand for the more complex whole. The reality is unlikely to have been as neat as Oliphant later narrated. Yet it is also true that providential moments of such a type can occur, and can shape the course of history. The encounter need not have been exactly as described: if the conclusion is that Marsden's passage through Washington inclined him to curiosity about British physicists' wartime interests, it is enough. If any New Zealander would have been able to deduce the existence of an allied nuclear programme, it would have been Marsden, whose scientific training (he had worked with Rutherford) and professional responsibilities alike would have equipped him to recognise the import of the three scientists' presence in Washington. There is, moreover, archival confirmation that the problems of nuclear physics were on Marsden's mind at this point: in December 1943, from Washington, Marsden wrote to the director of the New Zealand geological survey from asking him to start surveying for radioactive

[38] An eighth, Manssen, arrived in Canada only after the end of the war.
[39] Priestley, *Mad on Radium*, p.42; also in Rebecca Priestley, 'Ernest Marsden's Nuclear New Zealand: from Nuclear Reactors to Nuclear Disarmament', *Journal & Proceedings of the Royal Society of New South Wales,* 139 (2006), p.25

material.[40] At any rate, the latter part of the anecdote is where the account definitively ventures into archival fact, for Anderson and Marsden certainly spoke in the spring of 1944.

Oliphant's anecdote savours of truth in one other respect: Marsden seems to have been clear from the outset that New Zealand should be allowed to contribute in some measure to the programme. In the April of 1944 he reported that he had 'complained, unofficially, to the high Authorities… that New Zealand should have been made aware earlier of such an outstanding development and been allowed to participate'.[41] This desire to contribute was no idle aspiration. The idea that a small contingent of New Zealanders should be attached to Tube Alloys had already been floated. A document in the National Archives implies that Oliphant was involved in the discussion. Wrote Appleton:

> I believe that you have had a talk with Marsden about some New Zealand people who might be absorbed into the T.A. organisation. I wonder could you let me know what decision you have come to about these people and whether you are advising Chadwick that you should have them[42]

Thus, if Marsden had 'put in a good word' in Washington, he must also have followed it up in the following months. It is tempting to identify Marsden as the New Zealander in British uniform with whom Oliphant was alleged to have spoken in Berkeley, but this would be to rely far too heavily on supposition, and is anyway not necessary. Oliphant would have been a good informal point of contact for Marsden, and was himself very much in the market for additional manpower for his team at Berkeley.

In any case, the British welcomed the suggestion that a handful of New Zealanders might be attached to Tube Alloys in spite of (or perhaps because of) the slow progress being made with the Australians. There was also a clear sense as to who was wanted. Top of the list was Charles Watson Munro, whom Marsden thought 'the outstanding man in New Zealand for the job'.[43] To secure the release of five men, all of whom were already engaged in important war work, would require official sanction at a level far higher than Marsden, senior though he was. Marsden therefore made his case to the acting Prime Minister, Dan Sullivan, stressing the empire-wide shortage of suitable scientists, the potential implications of the technology, and the consequent desirability of associating New Zealanders with the programme.[44]

The concrete proposal was that five men be sent: C. N. Watson Munro, K.D. George, W.W. Young, R. M. Williams, and G. Page. All were already involved in relevant, secret war work, George as Scientific Liaison Officer in Washington, the others for DSIR in New Zealand. It was decided that Watson Munro and Page would be sent to Berkeley, the other three to Montreal.[45] These were young, capable men, very much of the '1851 standard'. In his stint as scientific liaison officer in Washington, George had married a Canadian – a more parochial instance of Commonwealth interaction.[46]

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[40] Priestley, 'Ernest Marsden's Nuclear New Zealand', p.26
[41] Marsden to Sullivan, 27th April 1944, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[42] Appleton to Oliphant, 23rd March 1944, AB 1/481 (TNA)
[43] Marsden to Sullivan, 27th April 1944, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[44] Memo, T.A. Project / Atomic Energy for Acting PM Sullivan, 5th July 1944, AAOQ W3424 Box 5, 74/-/- (ANZ)
[45] Ibid.
[46] DSD to Appleton, 8th August 1944, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)

This was undoubtedly a coup for Marsden. Williams, one of those to be sent, described Marsden as 'cock-a-hoop' at having secured the secondment of the New Zealanders.[47] The terms for the DSIR men stipulated that they were to be seconded for 'a period of one year or for the duration of the war, whichever is the longer'.[48] This would be be a long stint, but the terms were favourable to New Zealand: there was an expectation that the men would return home for at least one year after their service was completed, a stipulation which Priestley casts as evidence that 'Marsden was very keen for New Zealand to launch an atomic research programme when the war finished'.[49]

One alteration was ultimately made to this scheme: by the end of May Cockcroft was keen to have Watson Munro at Montreal, where it was felt that he would 'fill a gap in our present organisation in design of control mechanisms'. Work on these was due to begin within the next month, so the need was sufficiently urgent that a precious permit for air transit was in order.[50] Watson Munro was duly reassigned to Montreal; he would go on to play a significant role in the development of ZEEP, the Canadian heavy water reactor.

The first group of New Zealanders settled well at Montreal and Berkeley, and messages to Marsden – chiefly from Watson Munro, their *de facto* leader – made clear the value to New Zealand of having successfully seconded their personnel to the programme. The value, moreover, was mutual: their work was clearly well-regarded by the British, and in January 1945 Cockcroft cabled Marsden (seemingly at Watson Munro's suggestion) to ask that a few more personnel be sent. The greatest need was now for electrical engineers or electronic physicists. This was a clear vote of confidence, both in the capability of the New Zealand personnel already sent and in the discretion and effectiveness of Marsden and DSIR as the sending party. Whereas the Australians had struggled even to get Burhop placed at Berkeley, the New Zealanders were now being asked for further secondments.

Marsden was naturally keen to meet the British request. In the face of competing claims on New Zealand's thinly-stretched cadre of engineers, he asserted his belief that 'the T.A. project is the more important, both from the Empire point of view and from that of future development work in New Zealand'.[51] This two-fold argument – that the sending of more men was equally in the interest of New Zealand and the wider empire – was backed by appeals to authority. Marsden cited a communication from the New Zealand High Commissioner in Ottawa, opining that additional men 'could make [a] valuable contribution to Allied war effort here if available quickly' and that their experience would be 'useful to New Zealand' post-war. He emphasised the extent of support for it amongst the New Zealanders already in North America: 'I have full faith in Mr. Watson Munro's judgement in the matter'. He even invoked Rutherford: 'It is not inappropriate that New Zealand should help in this project since it owes its origin to the work of the New Zealander, Lord Rutherford'.[52] The appeals worked. Three men – Manssen, Allan, and Fergusson – were identified, and the administrative processes for their secondment were begun. Domestic complications delayed Manssen's

[47] 'Reflections on my involvement in the Manhattan Project', seminar at Victoria University 10th August 2001, quoted in Priestley, 'Ernest Marsden's Nuclear New Zealand'
[48] Priestley, 'Ernest Marsden's Nuclear New Zealand', p.25
[49] Ibid.
[50] Cockcroft to Webster, 31st May 1944, AB 1/197 (TNA)
[51] Marsden to Minister SIR, 11th January 1945, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[52] Ibid.

release until after the war, but the other two were able, after some minor administrative delays, to reach Canada, where they, too, contributed positively in the closing months of the war.

Parallel with the secondment of personnel, and also under the aegis of Marsden's DSIR, was the question of uranium exploration. New Zealand had never looked as promising a prospect as Australia or Canada, but it was equally impossible to rule out the discovery of exploitable deposits there, and the British were therefore keen to ensure that steps were taken to identify, and if necessary secure, any uranium sources within the Dominion's territory. New Zealand geologists had been forewarned by Marsden, and when the request was made they were ready for it. There were, moreover, no complications: Marsden made no effort to intertwine the uranium question with that of personnel. The war cabinet duly approved funding for a uranium survey in July 1944.[53] The resulting effort was substantial, a significant proportion of the survey work having to be conducted by boat, owing to the inaccessibility of the areas surveyed. Marsden, inevitably, took a considerable interest in its progress, intervening at points to keep the work on track. The urgency of the task was reinforced by messages home from Watson Munro, which Marsden was not averse to quoting in his memoranda to ministers. Witness the following excerpt, which Marsden included in a memorandum for his minister in February 1945:

> I trust the search (for Uranium and Thorium) is proceeding well. The work is very important from an Empire point of view as many tons will be wanted in the next few years and Uncle Sam has a stranglehold on the Canadian ores.[54]

These appeals to empire interests helped maintain the momentum of the search. Privately, though, it had to be admitted that there had been little success. Marsden acknowledged that 'This chasing of radioactive minerals is interesting but tantalising' – tantalising in the strict classical sense, for the prize of a rich seam of uranium seemed just out of reach.[55] It never, in fact, materialised. Skilled manpower was to be New Zealand's only realisable asset in the imperial nuclear marketplace. Recognition of this was the hallmark of Marsden's approach. Unlike the Australians, the New Zealanders made little or no effort to tie one strand to the other. Instead, they willingly made separate but vigorous efforts on both.

Marsden's centrality to New Zealand's early nuclear history is recognised in the (slim) historiography of the New Zealand nuclear programme, though there he must compete for the ultimate credit with Ernest Rutherford, upon whom both Priestley and Galbreath ground their accounts.[56] It is true that 'Nearly every British physicist involved in the wartime atomic energy effort had been one of Rutherford's 'boys'',[57] and a testament to the scale of his influence in (Anglophone/British empire) physics, but the suggestion that 'the Rutherford connection' – Galbreath's concept – served a practical purpose in positioning New Zealand scientists within the wider Tube Alloys contingent is harder to substantiate. By the outbreak of World War Two that 'connection' had undeniably been stretched by Rutherford's death and long absence from New Zealand. Residual goodwill towards the legacy of Rutherford is not, of itself, adequate explanation for

[53] Priestley, 'Ernest Marsden's Nuclear New Zealand', p.26
[54] Memo for Minister SIR, 15th February 1945, AAOQ W3424 Box 5 74/2/1 Part 1 (ANZ)
[55] [Marsden?] to CWM, 27th February 1945, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[56] Priestley, *Mad on Radium*, pp. 36, 42; Galbreath, 'The Rutherford Connection', p.310
[57] Galbreath, 'The Rutherford Connection', p.307

sensitive decisions around personnel. It would perhaps be fairer to say that Marsden's connection with Rutherford carried an almost life-long imprimatur, enhancing his credibility and consequently his influence. Even so, the credit for the actual conduct of New Zealand nuclear policy during the war is Marsden's.

Priestley and Galbreath's unanimity on the significance of Marsden and Rutherford is typical of their accounts of this period. There is little to choose between them; Priestley's work acknowledges a debt to Galbreath, and builds on many of his core themes. What deviations there are emerge on seemingly basic points, such as the overall number of New Zealanders who participated in the nuclear programme. This question of headcount is an interesting one, and is not exclusive to the New Zealand team: similar confusion as to numbers exists in reference to the British scientific presence at Los Alamos, for example. It does, however, highlight one of the problematic ambiguities in the idea of British citizenship in this period. Priestley, describing the arrival of Williams and Page at Berkeley in late July 1944, notes that 'two other New Zealanders were already working at Berkeley, having arrived from the United Kingdom with the British team'.[58] One of these was Maurice Wilkins, a physicist who represents a good case study in the ambiguity of Commonwealth nationality and the pitfall it represents for the historian. In what sense could Wilkins be described as a New Zealander? He had been born there, at Pongaroa on the North Island, but had left with his parents at the age of 6; his education, and later academic career, were all in Britain. Nimmo, the other New Zealander claimed by Priestley, had an even more itinerant background, and neither he nor Wilkins had joined the Manhattan Project by dint of any New Zealand connection. These ambiguities explain the various counts – Galbreath counts Nimmo, but not Wilkins, and Priestley counts both Nimmo and Wilkins. This thesis holds that, for anything other than retrospective national bragging rights, it is meaningful to consider only those who were sent under the official aegis of the New Zealand Government. This, in the period of the war, amounted to seven secondments: the five of the first contingent (George, Page, Watson Munro, Williams and Young), and the two of the second (Allan and Fergusson).[59]

New Zealand's wartime nuclear experience had been almost entirely positive – certainly compared with that of their neighbours across the Tasman Sea. The British had thought so too: not a word of recrimination seems to exist in the archives about the New Zealanders' conduct. If, by the end of the war, Rivett in Australia had had cause for disappointment, Marsden had cause for pride. He had been central to the success of his country's collaboration with Tube Alloys. He had been an enthusiastic advocate of New Zealand participation from the outset. His excitement for the project was unfeigned: at one point, following Cockcroft's request for additional men for Montreal, he volunteered himself for the project.[60] This boyish enthusiasm for the idea of the project belied a shrewd appreciation of its probable impact on the world. There need not be any hyperbole in his comment that the programme was 'of more significance than any other project with which we have had opportunity to collaborate'.[61] Time and time again, he made the case that 'By helping with the loan of men from N.Z. we shall render greater services to the Empire and ourselves than in any other way I know'.[62] It was this identification of empire service and national self-interest as

[58] Priestley, 'Ernest Marsden's Nuclear New Zealand', p.25
[59] Manssen, it will be recalled, arrived after the war. Other New Zealanders were seconded to Chalk River in the post-war period.
[60] Priestley, *Mad on Radium*, p.45, and *cf*. Marsden to Watson Munro, 15th March 1945, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[61] Marsden to Sullivan, 27th April 1944, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[62] Marsden to NZ PM, 17th May 1944, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)

mutually compatible that rendered his argument so strong; his belief in its truth may also account for his guileless approach.

Australia and New Zealand in Comparative Perspective

How was it that New Zealand succeeded where Australia failed? One might reasonably have predicted the reverse to be true: New Zealand had none of the advantages that Australia seemed to possess. So complex a course of events requires a multifarious explanation, but underpinning any explanation must be the simple fact that the New Zealanders were able to provide the British with something that the Australians were unable, or unwilling, to offer.

Both Dominions were sensitive to the differences in their experiences with Tube Alloys; all the more so as these differences became more pronounced. There was some measure of interchange between Marsden and Rivett in mid-1944. Rivett had hoped to rendezvous with Marsden at some stage in the latter's journey back to New Zealand in July/August 1944 – he told Marsden that 'there are many things about which I would like to have talked to you' – but the meeting never took place. Rivett seems to have had the idea of Australian reinforcements for Oliphant still in mind, and was therefore keen to learn what he could of the New Zealanders' experience:

> From what I have heard, you are likely to send several people from New Zealand and I should be most interested [to] hear anything that you would care to tell me about the situation.[63]

Whatever Rivett may have learnt through his contact with Marsden availed him little, for there was no change of policy on the part of the Australians. By the end of 1944, the two countries' experiences had diverged yet further, and observers from both were keen to establish why. One of the most perceptive interactions came on 4th January 1945, when Coop, the New Zealand scientific liaison in London, briefed Marsden:

> Apparently the Australians have been trying to get the low-down and have failed even at High Commissioner to Minister level. I gather that the root of the matter is that Australia wants the evidence first before going in boots and all, and the powers that be say that it has to be vice versa.[64]

The Australians, by this interpretation, were guilty of greed. They had demanded too much – information, attachment of personnel, a cohesive programme of collaboration – before they would commit anything. For the New Zealanders, the reverse had been true:

> Your case had been entirely different in that you had offered five good men without questioning the soundness of the purpose and the good faith of the British Government. Your

[63] Rivett to Marsden, 11th August 1944, AAOQ W3424 Box 5 74/-/- Part 1 (ANZ)
[64] Coop to Marsden, 4th January 1945, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)

> action was very much appreciated and Oliphant [with whom Coop had discussed it] drew a sharp distinction between their dealings with New Zealand and with Australia. They were very pleased indeed with our five men….[65]

Marsden's eagerness had paid off. His willingness to provide capable scientists with no conditions had resulted in an ongoing secondment relationship, with all its associated benefits. On one level, then, Galbreath's interpretation is sound:

> The New Zealanders were able, adaptable, and hard-working; the New Zealand government made no demands in return for their participation; and with the decline in DSIR's radar work … more were available for deployment[66]

It is, however, an incomplete explanation for the differing experiences of the two Dominions, for there was no reason why the Australians could not also have supplied able, adaptable, hard-working physicists. The fact is that they were not willing to do so, but instead pursued their ill-fated policy of consolidation.

Why?

It is hard to escape the conclusion that Rivett overplayed his hand. He seemed to have hoped that the granting of access to Australian uranium 'might serve as a quid pro quo for access to information'.[67] This attempt to associate the British request for survey work with the Australian desire to send more staff to the United States proved profoundly counter-productive, and it is difficult in retrospect to understand why it was attempted. Galbreath refers to it as an 'ingenuous approach', and notes that it achieved the very opposite of its intention, for 'consideration of further Australian scientists for the atomic energy projects was deferred and then dropped, and access to any information was firmly denied'.[68]

Both Marsden and Rivett grasped the likely significance of nuclear power and the advantages that stood to be gained by their Dominions from involvement in its development. 'It is more important', Marsden said, 'than anything yet brought to our notice not only for the war but to us in N.Z. afterwards'.[69] Rivett, by his actions, demonstrated the same perspective, which Oliphant had repeatedly impressed upon him. The difference came in how they responded to the opportunity when it arose. Rivett sought to maximise Australia's gains, by leveraging each of his Dominion's resources in a straightforward negotiation with the British. Marsden, perhaps guided by a more acute understanding of the relative contribution his small Dominion was likely to make, made no effort to leverage his position, or really to negotiate, but rather trusted that the mere exposure of their personnel to the programme would, in time, reap dividends. The offer that came from Australia was conditional, almost confrontational – the first gambit in a negotiation. The offer that came from New Zealand was enthusiastic, unencumbered with conditions, a sincere contribution to the allied/imperial war effort. Little wonder the British favoured the New Zealanders.

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[65] Ibid.
[66] Galbreath, 'The Rutherford Connection', p.313
[67] Cawte, *Atomic Australia,* p.7
[68] Galbreath, 'The Rutherford Connection', p.309
[69] Marsden to Sullivan, 17th May 1944, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)

It is tempting to extend this line of argument, and suggest that the different approaches pursued by Rivett and Marsden reflected the wider proclivities of their Dominions, the Australians inclining to a more independent line than the acquiescent New Zealanders. This would fit the historiographical meta-narratives of the two countries, which in accounting for wartime policy-making stress pro-active nationalism in Australia's case and a more subservient, empire-oriented tendency in New Zealand's. It would, however, be excessive. For one thing, Rivett cannot bear all the blame; there were other personalities and other prerogatives at play in the Australian case. Watson Munro, seeking an explanation for the administrative delay which had postponed Fergusson and Allan's departure for Montreal, advanced the following theory:

> apparently the delay in London was associated with the offer of men by another Dominion (Australia) being rejected. I don't know why, because the Aussie boys would have been useful – now this is pure guesswork on my part – it may have been White who offered them and the U.K. may not have liked the way the cake was offered[70]

White was a figure in CSIR. Oliphant appears also to have disliked him.[71] It is unlikely that personal animus alone could have led to the rejection of the Australian offer, but it cannot have helped. Equally, Marsden is not unambiguously representative of New Zealand (no one figure ever could be). Although many historians, including Gowing, have assumed that he was born a New Zealander, Marsden was born in Britain, and owed his role in New Zealand DSIR to Rutherford, under whom he had studied at Manchester.[72]

Other explanatory factors might be invoked. Rivett may simply have played the diplomatic game less well than Marsden, though neither was a trained diplomat. Marsden may have had a few advantages which inclined the Tube Alloys hierarchy to trust him: Rivett, a chemist, had not studied under Rutherford: Marsden, a physicist, had. These can only ever be supplementary to the core explanation, however: that the attitude underlying the New Zealand approach proved attractive to the British, whilst the Australians' proved unattractive. These two attitudes were shaped, in turn, by variant understandings of how their Dominions could hope to relate to the British nuclear programme. That, perhaps, was the essential difference: between a conception of British and Dominion interests as complementary, verging on identical (the Marsden/New Zealand model) and as distinct and potentially irreconcilable (the Rivett/Australia model).

Resources of the Wider Empire

It was not solely to New Zealand and Australia that the United Kingdom looked for aid. Britain had gone to war alongside her empire, and with the instinct to make use of its full strength in collaborative endeavour. This was as true in the nuclear field as elsewhere, for although the constraints of the Anglo-American relationship and the burdens of secrecy precluded most forms of collaboration with the wider empire, there remained a crucial sense in which it could be leveraged in support of Britain's nuclear interests. The

[70] Marsden to Shanahan, 20th March 1945, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[71] Coop to Marsden, 4th January 1945, AAOQ W3424 Box 5 74/10/- Part 1 (ANZ)
[72] Galbreath, 'The Rutherford Connection', p.310; Gowing, *Britain and Atomic Energy*, p.10

acquisition of uranium was fast becoming a strategic priority – not for the wartime programme *per se*, but for all that would follow. It seemed logical, from a British perspective, that her imperial connections should serve to benefit the British programme. The Declaration of Trust strengthened this impulse, for it encoded the idea of British pre-eminence within the empire, self-governing or otherwise. It acknowledged the empire as, in effect, a mineral sphere of influence. The exploitation of empire resources is a well-worn historiographical trope, but is true enough in the context of the colonial empire. In the Dominions the dynamic was somewhat different, as Australia and New Zealand have already demonstrated, for the Dominions possessed what the colonies lacked: agency. These variant dynamics are the subject of this section of the chapter.

The process of seeking out a British-controlled source for uranium began prior to the implementation of the Declaration of Trust. A paper on 'Sources and Supplies of Uranium' was prepared in December 1943, discussing the extent of global uranium supplies. The only known exploitable deposits lay in the United States, the Belgian Congo, and Canada, but a further ten countries were listed as having known or suspected deposits of unknown quality. These were Portugal, Australia, Tanganyika, Madagascar, India, Uganda, South Africa, Britain, the USSR, and China.[73] The majority of these lay within the British Empire: Britain itself, two Dominions, two colonies, and the grand anomaly of India. It was reasonable to hope that at least one of these territories would be found to have viable deposits – thereby securing for Britain an independent source of the mineral which seemed set to dominate world affairs. The paper therefore gave concrete recommendations. It urged that the Australians (who were already aware of the potential significance of uranium) be requested to start surveying. It also made clear that a decision would soon be needed about surveying and prospecting in 'other territories under British control … from the long term point of view of assuring supplies of uranium for British T.A. work during the next decade'.[74] To be thinking on a decade timescale was, of course, to be thinking post-war.

Here, again, was the essential tension between Britain's fealty to the pressing objective of an allied bomb (as required in the Quebec Agreement) and her longer-term desire to develop her own nuclear programme. Chadwick, though, was clear that the settlement of the Montreal question and the subsequent prioritisation of the work in North American did not preclude the pursuit of preparatory work in England, such as the accumulation of a stock of uranium oxide.[75] Akers concurred, arguing in April 1944 that in order to begin large-scale work in the United Kingdom, and 'as an insurance against a possible breakdown in American co-operation in the Montreal project' the UK should take immediate steps to secure 'essential raw materials'.[76]

By 'essential raw materials' Akers had in mind the basis of a post-war programme: the requirement would be approximately 400 tons of graphite, the capacity to produce one ton of heavy water per month, and 1000 tons of uranium oxide.[77] It was widely accepted that uranium was the most pressing of these to obtain – in

[73] 'Sources and Supplies of Uranium', 17th December 1943, AB 1/504 (TNA)
[74] Ibid.
[75] Chadwick to Anderson, 7th April 1944, AB 1/113 (TNA)
[76] Akers, Review of Present Position of American Work and Suggestions for British Policy and Programme', 14th April 1944, AB 1/528 (TNA)
[77] Ibid.

part because of its natural scarcity, but also because 'the Americans are apparently trying to get a monopoly'.[78] Some territories were obviously to be prioritised over others, but it would be well to take action more widely, against the possibility that deposits might later be discovered. This meant looking to the empire, both the Dominions and the colonial possessions. Doubts about Australian and Canadian supplies – certainly as long-term prospects – had already been expressed.[79] An approach therefore had to be made to the Colonial Office (tentatively, giving away 'no more than was necessary'). Although neither the Colonial Office nor Tube Alloys were aware of any significant supply within the Colonial Empire, both nevertheless agreed on the advisability of immediate action, first, because of the risk that new deposits might accidentally be found, and second, that wartime conditions were uniquely amenable to rapid, secret, sweeping action:

> while the war is on there is always the chance that any desirable new regulation can be hitched on to some omnibus regulation which a colonial Government may be issuing for war purposes, and so secure the minimum of publicity. Action of the kind we want might not be so easy to take unspectacularly once the war is over[80]

Although the British were satisfied that the were no deposits unaccounted for, they could not rule out future discoveries, especially in 'India, S. Africa, S.W. Africa, Rhodesia, Uganda, Tanganyika, Kenya and possibly Nigeria'.[81] Policy towards those territories under British control was further elaborated in a paper on 'T.A. Control in the Colonial Empire'. Secrecy was to be the order of the day; only a handful of Colonial Office staff were to be informed of the interest, and little information was to be given as to the reason.[82]

For the Dominions, a rather different approach was required. One could not simply dictate from Whitehall to acquiescent British governors. Consent must instead be sought, and from the highest levels. This, in turn required explanations, delivered, if possible, in person, of the nature of the problem. An opportunity was presented by the presence of the Dominion prime ministers in London for their conference. None of them had yet been formally approached, except Curtin, and him only very recently.[83] The timing was serendipitous, for this was the period of the negotiations for the Declaration of Trust, which would commit Britain to safeguarding empire nuclear resources.[84] The urgency of the approach varied. There were no known uranium sources in New Zealand, but it was still considered necessary to appraise Fraser of the element's importance (his government already having learnt, via Marsden, of the existence of the programme). In South Africa there was only a set of pitchblende deposits at Gordonia, about which further information would be welcomed.[85] Only the approach to Curtin was predicated on any real expectation of results.

Australia and New Zealand have already been discussed in this chapter, and need not be revisited here – save to reiterate that Australia's apparently vast resources availed her little in the attempt to secure greater

[78] Cherwell, 'The Tube Alloys Position', c. March 1944, PREM 3/139/2 (TNA)
[79] *cf.* 'Paneth, Notes on Uranium Deposits', 15th January 1944, AB 2/20 (TNA)
[80] Sayers to Gorell Barnes, 25th May 1944, AB 1/298 (TNA)
[81] Gattiker to Gorell Barnes, 9th May 1944, AB 1/298 (TNA)
[82] 'T.A. Control in the Colonial Empire', *circa* May 1944, AB 1/298 (TNA)
[83] [Sayers] to Gorell Barnes, 17th May 1944, AB 1/586 (TNA)
[84] [Gorell Barnes] to Anderson, 18th May 1944 (TNA)
[85] [Sayers] to Gorell Barnes, 17th May 1944, AB 1/586 (TNA)

access to the nuclear project, and that New Zealand's lack of comparable prospects may ultimately have been a blessing, for it spared them the hubris of attempting to do the same. Instead, it would be well to consider the last of the Dominions to enter into the nuclear secret during the war. South Africa did not contribute any personnel to the British contingent in North America; there appears not to have been any suggestion that she should. Yet by the summer of 1944 news of the work had reached the Union's formidable Prime Minister, Jan Smuts, via several routes. In May, Lord Cherwell had reflected, in a note to Churchill, on the fact that Smuts, alone of the Dominion prime ministers – all of whom were then present in Britain – had not been exposed to the secret. The others were all, to varying extents, *au fait* with Tube Alloys, and in most cases appeared keen to talk about it:

> Mackenzie King knows all about it and Curtin – owing to our endeavours to secure Australian ore – a good deal; Fraser, having evidently been kept abreast by his own scientists, opened the subject…[86]

To Cherwell there therefore seemed little harm in inducting Smuts, too. Anderson clearly concurred, for on 25th May he asked Churchill for permission to discuss the programme personally with the South African Prime Minister. His reasoning was similar to that which Cherwell had outlined: the rest of the Dominion Prime Ministers were by now relatively well-informed, and keen to discuss the subject.[87] Churchill, rather a fan of Smuts, readily agreed with his lieutenants, telling Anderson that he was 'quite willing that you should discuss Tube Alloys with Field-Marshal Smuts. I propose to do so myself'.[88] There was no pressing need for such an action: only at Gordonia were there known to be any even vaguely interesting resources.[89]

Churchill's eventual discussion with Smuts clearly went beyond the essential facts, for in June 1944, Smuts wrote, by hand, to Churchill, noting, seemingly without irony, that 'You mentioned to me the agreement between you and the President about the scientific secret and also that you were not willing to disclose it to a third party'.[90] Nor was Churchill the only Briton to have shared such information with Smuts ('Anderson and the Prof [that is, Cherwell] have also raised the matter with me').[91]

Smuts' analysis was concise, and he seems to have been fully cognisant of the future implications of the new power. He cautioned Churchill not to mention the weapon to Stalin, insisting that any move to consult others should come first from the Americans. (One must assume that both men mentally exempted the British Empire from that principle, for it was obvious that consultation among the Dominions had already taken place, and would continue). Still, the secret could not be kept forever, and 'its disclosure after the war may start the most destructive competition in the world'.[92] Smut's conclusion was therefore clear: 'If ever there was a matter for international control this is one'.[93] What is absent from Smuts' otherwise very thorough letter is any suggestion that South Africa might somehow participate in the British programme. Perhaps this had to do with the context in which he learnt of the project. Churchill's concern seems to have

[86] Cherwell to PM, 17th May 1944, PREM 3/139/11A (TNA)
[87] [Anderson] to Churchill, 25th May 1944, PREM 3/139/11A (TNA)
[88] WSC to Anderson, 26th May 1944, PREM 3/139/11A (TNA)
[89] AMSSO [?] to JSM Washington, 21st July 1944, AB 1/298 (TNA)
[90] Smuts to Churchill, 15th June 1944, PREM 3/139/11A (TNA)
[91] Ibid.
[92] Ibid.
[93] Ibid.

been with questions of the Anglo-American relationship and future world order, rather than with the development of a uniquely British weapon. Smuts' induction also came later, and since there had been no previous contacts at other levels he had no Marsden/Rivett figure primed to advocate his Dominion's involvement. Dire warnings from Niels Bohr may also have shaped some of Smuts' thinking.[94] Whatever the reason, no appetite for South African participation was evident. Smuts' counsel to Churchill was pretty well the sum of his country's wartime contribution to the programme.[95]

Another case, more marginal even than that of South Africa, was that of Southern Rhodesia, where no deposits had hitherto been found, but which was considered, on the basis of its geological characteristics, a sufficiently promising future source that here, too, 'immediate steps' should be taken. [96] Advice was sought from the Dominions Office, which informed them that since Southern Rhodesia had self-governing status the aptest approach would be for the Chancellor to 'have a word' with the Prime Minister, Godfrey Huggins, before his departure from Britain;[97] in short, the same approach as had been used for the Dominions, but with less information shared. (Recall that Southern Rhodesia was not, in a constitutional sense, a Dominion, though it was at times treated comparably). There was little or no prospect of collaboration, no expectation of active interchange: the concern in this case was simply to ensure that the government of Southern Rhodesia would inform the United Kingdom of any relevant developments, but otherwise keep very quiet on the matter.[98]

By July 1944 the necessary work was well underway in each of the key Dominions. Promising deposits in Australia were under exploration. Requests had been made of the South Africans and New Zealanders, who had taken appropriate measures. Huggins had likewise been informed, though the sense from Southern Rhodesia was now that not much of interest was likely to be found.[99] The approach in the colonial empire necessarily had to be different. Governors had been told of UK government interest but no reference had been made to specific elements.[100] Restricting legislation to the broad category of 'radioactive minerals' served to obscure the two or three substances of genuine relevance. The precise approach to be adopted would depend on the policy adopted by the CPC and CDT, but a legal framework could be prepared now – for which an understanding of the legal position in each of the colonies was required. A number of legal instruments were envisaged: restriction of new mining concessions, qualification of existing concessions, and/or export controls were to be introduced as necessary. Alongside these pre-emptive legal actions would also come the active investigation of sources, directed from London, beginning with likeliest candidates – Tanganyika and Uganda – and expanding to others where necessary. This would be a TA-led process, conducted by a geologist/mining engineer, but using the good offices of Colonial Office, who would additionally help to compose 'a list of the territories whose Governors should at once be made aware of the necessity for referring to us any information or action affecting radioactive minerals'.[101]

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[94] *cf.* Martin J. Sherwin, *A World Destroyed,* p.106*;* Graham Farmelo, *Churchill's Bomb: A Hidden History of Science, War and Politics* (London: Faber and Faber, 2013)
[95] See Chapter Six
[96] Sayers to Gorell Barnes, 3rd June 1944, AB 1/298 (TNA)
[97] Sayers to Gorell Barnes, 3rd June 1944. AB 1/586 (TNA)
[98] Aide Memoire, 7th June 1944, AB 1/298 (TNA)
[99] AMSSO to JSM Washington, 21st July 1944, AB 1/298 (TNA)
[100] Ibid.
[101] 'T.A. Control in the Colonial Empire', *circa* May 1944, AB 1/298 (TNA)

In all of this the contrast with the Dominion experience is clear: the colonies were only ever treated as subsidiary. There was little sharing of information, even with British governors. A visiting delegation of Indian physicists to Canada was consciously given a very wide berth by the nuclear elements of the NRC.[102] This was, in part, a reflection simply of constitutional realities: the sovereign independence of the Dominions meant that relations must be consensual; Britain could not simply dictate. Unlike the Colonies, the Dominions were not simply sources of material to be suborned or exploited, but rather were seen as actual or potential collaborators to be cultivated.

Conclusion: Mobilising the Commonwealth

The Dominions interacted with Tube Alloys, and the very world of nuclear weapons development, in complex ways. This chapter has sought to convey both the commonalities and the distinctions. Canada, of course, had gained the most: by no real act of her own, but rather as a result of her location and her Dominionhood, she had gained a seat at the highest table, playing host to an increasingly ambitious programme and with access to secrets which were otherwise held scrupulously close. The other Dominions could hardly have hoped to have achieved the same. Yet they still gained information, access, and experience. Australia and New Zealand were both able to place personnel into crucial research centres – something which few other states managed, by fair means or foul. They had gained advance knowledge of the future importance of uranium resources, and had been able to commence exploration work, subsidised by the British government. In a world in which even the knowledge that the phenomenon of uranium fission might be militarily exploitable was considered the most secret of secrets, it must be recognised that the Dominions' collective interactions with nuclear technology were remarkably deep and wide-ranging. With the end of the war in sight, they could rest in either the satisfaction or the consolation that, albeit to varying degrees, their governments had made tangible contributions to a grand Empire endeavour, and that they could expect to reap the benefits; not simply those already accrued, but those that would surely come in the brave new world of the allies' nuclear peace.

[102] Webster to Cockcroft, 15th December 1944; Mackenzie to Webster, 23rd December 1944, RG77-D-1-b. Box 283 'Radiological Research – Miscellaneous' (LAC)

Chapter Six:
Post-War Planning

The destruction of Hiroshima occupies a unique position in human history. In historiography, as in literature and the human psyche, it has come to be regarded as a watershed, at once representing the culmination of the carnage of the Second World War and the grim dawn of the nuclear era. The use of the atom bomb instantly initiated global society into a scientific secret which had formerly been held so closely that few even of the allied leadership had known of it. Prior assumptions about the nature of the long-anticipated peace were challenged; old axioms about conflict and statecraft no longer stood. The obliteration of Hiroshima on the 6th of August, and of Nagasaki three days later, occasioned a fundamental transition in the strategic, political and cultural perspectives of every state even tangentially concerned in the late war, and of Britain foremost. Yet from a perspective of policy-making and institutional change this transition did not take place at precisely 0815 on 6th August 1945, but progressively, across months and years either side of that terrible moment. The atomic peace had been conceptualised and prepared for by the atomic allies. Plans had been lain, jointly and severally, for future work. That few of these wartime expectations were realised in their original forms does not diminish their relevance, for it was through the interaction of these expectations with the realities of the post-war period that subsequent policy was set. This chapter, then, is concerned with post-war planning both in the abstract – as envisaged by the scientists, politicians and policy-makers concerned – and as the material process of prioritisation that emerged from the effort to give substance to those idealised visions. Commonwealth dynamics will be seen to have had significant influence in both instances.

This chapter emphasises three themes in Britain's post-war policy-making, addressing each in turn. First, it is noted that the transition from war to peace brought with it, after the grim revelations at Hiroshima and Nagasaki, an alteration in the conditions of nuclear policy-making on both sides of the Atlantic, from a situation of extreme secrecy and limited oversight to one of full publicity and intense (though frequently ill-informed) public and political scrutiny. Variant political approaches to these new circumstances further complicated the already fraught tripartite nuclear arrangement, which for the British meant the frustration of many wartime plans. Yet some wartime planning did bear fruit: the conditions may have changed, but the expectation that Britain would use the advent of peace to pursue large-scale work in the United Kingdom as soon as practical was met, even against the backdrop of American prevarications. Second, this chapter traces the awkward recalibration of Anglo-Canadian nuclear ties, which peace and the pursuit of independent work in the United Kingdom disrupted. Differing conceptions of the nature of the Canadian nuclear work, which had been masked somewhat by the exigencies of war, now came to the fore, and the minor cleavages of previous years grew more severe as a result of divergent ambitions and poor communication. Yet even as the British and Canadian programmes drifted further apart from one another, new forms of collaboration and interaction emerged, still with unique Commonwealth dynamics. Third, and finally, the chapter considers the role played by the other Dominions in this period, both as independent actors with nuclear assets, and as contributors, real or potential, to Britain's post-war nuclear programme.

Dominion experiences in the immediate post-war period were as varied as they had been during the war. Australia and New Zealand each sought to build their own nuclear capabilities on the basis of their wartime engagement with the United Kingdom, the Australians still placing great emphasis on Mark Oliphant as their fount of nuclear knowledge, the New Zealanders under Marsden continuing to emphasise their small programme of secondments as mutually beneficial. For South Africa, meanwhile, the question of resources loomed largest, as Smuts' government sought to capitalise on the global surge in demand for uranium. In each of these cases the British attitude towards collaboration was shaped by an instinctive desire to leverage Commonwealth connections, tempered, and in some instances almost wholly frustrated, by the overwhelming importance of the American connection.

British Expectations, Before and After Hiroshima

The atom bomb precipitated the end of the war, but was not necessary to secure it. Victory had been achieved in Europe without nuclear weapons, and the material balance in the Pacific War so strongly favoured the allies that by 1945 victory was essentially a question only of time, blood and treasure. Little need be said here on the vexed issues of the morality and utility, in strategic and political terms, of the use of the bomb, the topic having been more than adequately debated elsewhere. It suffices to note that – courtesies associated with the Quebec Agreement notwithstanding – this was essentially an American strategic decision. American operational control did not, however, preclude British thinking about (and planning for) the wider nuclear future. The purpose of this section is to consider the essential features of these British plans for post-war nuclear work, both as they were formed during the war, and as they evolved in the early months and years of peace. In this, of course, the relationship with the United States looms large, and this section can therefore also be read partly as a condensed history, from a British perspective, of Anglo-American nuclear engagement from August 1945 to January 1947.

The paradigm shift portended by the development of nuclear weapons had been acknowledged in Britain from the earliest stages of the war. Frisch and Peierls had spoken of the weapon's likely military implications in their memorandum, and Moore-Brabazon, reflecting on the work of the MAUD Committee, worked through some of the implications for world order of an Anglo-American bomb;[1] the concept of post-war control had been on Anderson' mind even in the negotiations with the Americans in 1942.[2]

Wartime priorities had motivated the transfer of the bulk of the British work across the Atlantic, but the expectation of post-war activity meant that the British never loosened their grip on any element of their basic programme. As earlier chapters have shown, British policy on collaboration was consistently predicated on the idea that Britain should remain as near to the cutting-edge of nuclear research as possible. The fruit of that dogged (and risky) application of policy was the eventual agreement of the Americans to endorse the Anglo-Canadian heavy water project, in spite of its negligible relevance to the Manhattan Project. It was readily apparent that neither ZEEP nor NRX would produce weapons-relevant material in time for deployment during the war, and the Anglo-Canadian work on plutonium extraction was hardly

[1] See Chapter One
[2] Draft, Anderson to Bush, 21st July 1942, AB 1/578 (TNA)

necessary to the allied effort. The Canadian plant at Chalk River was thus tacitly recognised by the British and their allies as a post-war endeavour: references to post-war conditions, and to tripartite co-operation as the expected bedrock of those conditions, began to appear more consistently in Tube Alloys correspondence from then on.[3] By the summer of 1944, Akers and Perrin felt able to recommend that 'consideration should be given to planning the direction of T.A. work in this country' for the post-war period, 'under the assumption that full co-operation is maintained'.[4]

Planning for such an eventuality began in earnest in late 1944. A cross-section of senior figures in the British contingent in North America met in Chadwick's office in November 1944. Their intention was to put flesh on the bones of an idea broached in the Tube Alloys consultative council, that an experimental establishment should be created in the United Kingdom. 'It was generally agreed', the minutes read, 'that the establishment would be designed primarily for work on T.A. as a weapon', though other, more peaceable developments were to be expected in due course. The gathered scientists envisaged a small permanent staff, but with a 'continual flow' of younger personnel spending a year or two at the establishment as part of their doctoral work, and with senior university staff passing through in their vacations.[5] Dominion involvement was explicitly anticipated – in fact, it was to be encouraged; they were to be invited 'to co-operate as free partners, contributing men and possibly factories'.[6] The idea of contributing men was nothing new; it would require only the continuation and expansion of the secondment system which the New Zealanders had piloted. The idea of the Dominions contributing factories was, however, somewhat novel, and speaks of the emerging hope that post-war conditions might enable the construction of a collaborative inter-Dominion programme centred on British strategic requirements. A set of notes in Oliphant's hand likely pre-dating the group discussion, echo the themes of the meeting so closely that it would appear that Oliphant himself was the chief advocate of a Commonwealth-oriented programme in the United Kingdom. His notes envisaged the new UK establishment as the centre of a web of Commonwealth connections:

> The British Dominions should be invited to co-operate in the T.A. project as full partners, contributing men to work and to be trained and possibly providing factories where a process can more easily and more quickly be carried out in the Dominions. In this way we will tap a very useful supply of good men and will strengthen the whole project by giving the whole Commonwealth a stake in it.[7]

The wording here, more so than that minuted for the subsequent discussion, draws attention to the potential of the Dominions to supplement British manpower – an opportunity to which the late success of the Anglo-Canadian collaboration and the proven efficacy of the New Zealand contingent attested – but also highlights the idea of achieving Commonwealth buy-in to the British programme. Certainly the conception was that the new facility should serve as the focal point for the United Kingdom's nuclear-scientific diplomacy:

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[3] See, *inter alia*, Halban to Akers, 21st April 1944, AB 1/379; MacDonald to Dominions Office, 27th April 1944, AB 1/541; Cherwell to PM, 30th June 1944, PREM 3/139/11A (TNA)
[4] Akers & Perrin, 'Position of Directorate of Tube Alloys', 13th July 1944, AB 1/286 (TNA)
[5] 'Record of Discussion Held in Dr Chadwick's Office on 11th & 12th November, 1944', AB 1/213 (TNA)
[6] Ibid.
[7] 'Organisation of a research and development laboratory for the T.A. problem', *circa* November 1944, AB 1/214 (TNA)

another source from the same period states that 'The Establishment shall take the responsibility for scientific liaison with U.S. and the Dominions'.[8] There was, in essence, an expectation that Britain's Commonwealth and nuclear policies could be readily aligned.

These plans were not necessarily to the exclusion of the work at Chalk River. Some form of continuity of Anglo-Canadian collaboration into the post-war period had always been assumed: there was a commitment to '…an orderly transition to a post war basis of work' in the September 1944 five-year plan for Chalk River.[9] The British seem not to have foreseen any issue even if the greater part of the British staff in Canada should eventually return to staff the UK establishment.[10] A discussion was held in Canada in November 1944 on the topic of the future development of piles in Canada and the UK, which anticipated, amongst other lines of research, the construction of a pile for the production of fissile material.[11] (Power generation and multiplication of U233 stocks were also envisaged). The next month a new committee, the 'Future Systems Group', was convened at Montreal under Cockcroft. The group met seven more times before the end of the war, discussing technical problems associated with planned and potential new systems. Though based in Canada, the group – composed primarily of British team members – was steered to a considerable extent by an understanding of British priorities: in May 1945, after a trip to England by Cockcroft, the minutes record a distinct shift in emphasis, with the clear priority now breeder piles for fissile material production.[12] Chadwick attended the seventh meeting, held on 21st June 1945, and expressed his sense of the primary requirement: 'to accumulate an adequate stock of pure fissile material for military purposes'.[13] The Future Systems Group was in no sense a wartime undertaking as the Americans would have understood it, nor was its scope wholly, or even primarily, Canadian. This was a committee orientated towards Britain's postwar nuclear programme. (The group was resurrected at Chalk River in the spring of 1946, with a somewhat more Canadian bent, but met only three times; in June 1946, after the departure of many of the British personnel, it was subsumed into the Chalk River design groups).[14]

The British proposal, then, was to create a nuclear research establishment of their own, but to do so on the basis of the continuation of wartime ties and the introduction of further Dominion contributions. To achieve this, though, would require immediate practical action. Personnel must be recruited; a site must be found; and above all an actual programme of research and development work must be decided upon. Oliphant, stressing the urgency of action in Britain for the sake of the whole Commonwealth, advocated the early withdrawal of some or all of the the British personnel.[15] Chadwick disagreed: the imperative to support the joint programme and to proceed only on the basis of mutual agreement through the CPC outweighed the desire to get started on Britain's post-war project.[16] There the matter rested. The manpower requirement for the new establishment, and for British nuclear physics work more broadly, was to be met through the return of staff from North America after the war had ended. This could not be achieved through the simple

[8] Notes on Administration of Experimental Establishment, undated, AB 1/213 (TNA)
[9] Cockcroft and Steacie to Mackenzie, 20th September 1944, RG77-D-1-b. Box 284, 'Radiological Research. Policy Vol. 1'
[10] *cf.*: Papers on 'The future of the N.R.X. Project in Canada', 27th September 1944 and 'The future of nuclear technology in Canada', 17th August 1944, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[11] 'Notes on the Discussion of 4th November, 1944 on Future Developments in Pile Building', AB 1/335 (TNA)
[12] 'Minutes of the fourth meeting of the future systems group, May 14, 1945', AB 1/335 (TNA)
[13] 'Minutes of the Seventh Meeting of the Future Systems Group', 21st June 1945, AB 1/335 (TNA)
[14] Minutes of the Future Systems Group are held in AB 1/335 (TNA)
[15] Oliphant, 'Notes on T.A.', 9th January 1945, CAB 126/181 (TNA)
[16] Chadwick to Akers, 22nd December 1944, CAB 126/181 (TNA)

reassignment of personnel, however, for one obvious consequence of peace would be that civilians could no longer be so easily marshalled in support of government projects. Demands that had been tolerated in the context of the war effort could not continue to be made in peacetime. As a result the coming of peace would precipitate a mass return of mobilised scientists to academia and industry. Steps were therefore taken to ensure that at least some proportion of the existing staff might instead be attracted to work in the new establishment. A survey of North American staff in February and March of 1945 indicated that a reasonable number were, indeed, interested in joining.[17] It is worth noting that recruits were to be drawn from the British contingents in the United States, too; many of the Britons who participated in the 'exodus' (Frisch's phrase) from Los Alamos immediately after the end of the war took up posts with AERE.[18] Many of these returnees from Los Alamos travelled via Montreal and/or Chalk River, staying, in some cases, for weeks at a time. The opportunities for knowledge transfer this afforded cannot have been one-directional.

The first of the prominent returnees was Oliphant, who in the spring of 1945 had flown back to the United Kingdom, and ostensibly to academic physics; he reoccupied his chair at Birmingham, seemingly desiring only to complete his cyclotron and to build a synchrotron.[19] Yet the impression this gives of a return to civilian life – Cincinnatus to his plough – is false. Back at Birmingham, Oliphant remained closely associated with the British nuclear establishment, and though his star waned rapidly in the post-war period his involvement in the establishment of Harwell and the initial deliberations of the peace-time technical committee attest his significance in the first few years. One of Oliphant's principal contributions in this period was in the selection of a site for the new establishment. Site visits were conducted at more than a dozen possible locations throughout the spring of 1945. Some were conducted by Oliphant alone, though most were joint efforts with other colleagues.[20] Although no final decision was made until after the war, it was Oliphant's first choice, Harwell, an airfield south of Oxford, that was eventually chosen.[21]

With an earmarked site, and a workforce *in potentia*, all that remained to be determined was the precise programme to be pursued. The production of fissile material was to be the principal objective of Britain's post-war work, but it was not necessarily clear which type would be desired. Britain had a reasonable knowledge of enrichment methods, so a focus on U-235 would make sense; but all evidence pointed to plutonium as the superior material. Work on heavy water piles was well under way at Chalk River, so from the point of view of speed and complementarity a graphite pile appealed. Design of such a pile would be difficult, though, not least because of a lack of information from the Americans: British knowledge of the precise design of the piles at Hanford was 'confined almost entirely to hearsay evidence'.[22]

The global shock of Hiroshima had likewise been prepared for by all three of the nuclear partners, whose immediate statements (already discussed in the introduction) illuminate interesting differences in perspective. The Americans' report contained only tangential references to early British work, and to the

[17] Questionnaire to UK staff re: Transfer, Akers to Cockcroft, 24th March 1945, AB 1/152 (TNA)
[18] Frisch, *What Little I Remember*, p.191
[19] J.D. Lawson, *Early British Synchrotrons: An Informal History* (Rutherford Appleton Laboratory: Council for the Central Laboratory of the Research Councils, 1997), p.24
[20] 'Possible Sites for Tube Alloys Experimental Establishment', 27th September 1946, AB 1/165 (TNA)
[21] 'Summary of visits paid to possible sites for experimental establishment', Oliphant and Longair, 28th May 1945, AB 1/213 (TNA)
[22] 'Panel on enriched systems meeting', 30th April & 5th May 1946, AB 1/460 (TNA)

contributions of the British team.[23] The British long regretted the 'omissions and worse' in the American account,[24] which survived into the published version in spite of British efforts at correction. There was particular embarrassment around the treatment of the French and the general question of the chronology of (and impetus for) the early work. Akers, inured by now to American insensitivities, observed stoically that 'Nothing we can do will ever prevent the Americans from claiming priority in all inventions'.[25] There was solace, however, in occupying the moral high ground in their own account, issued 13th August, which elicited the satisfying prize of French appreciation, in writing, of the sense of 'fair play' by which credit for early work was apportioned.[26] The British account, written rather more hastily than the American, was consciously portrayed as complementing the Smyth Report, emphasised cross-border interactions and glossed over the frictions: there was no hint given of the trials which the negotiators endured before and after the Quebec Agreement (which itself, as a secret agreement, was left unmentioned).[27] The parallel Canadian account meanwhile reflected uniquely Canadian emphases. On the one hand, it was produced to enable the media and the public to 'evaluate the part Canada has played',[28] and stressed Canada's entry 'as a pioneer into an important new field of technology'.[29] Yet these emphases emerge alongside references of a more imperial character. Most notably, the team in Canada was described as 'The largest and most distinguished group of scientists ever assembled for a single investigation in any British country'.[30] The Canadian statement also gave detailed lists of the scientists on the staff of the Montreal Laboratory, in two categories: 'Canadian scientists' and 'scientists from abroad'. The latter category covered the British, French, American and New Zealand contingents. The fluidity of Commonwealth identity rendered some of the distinctions somewhat arbitrary, however: A.G. Ward ('Queen's University, Kingston, Canada; Cambridge, Eng.') is listed amongst the 'scientists from abroad', whilst N. Miller ('(University of London), Liverpool, England') is counted amongst the Canadians.[31]

The revelation of the bomb's existence and the transition to peace both demanded organisational change. The administrative footing of Tube Alloys was changed, bringing with it a departmental shift and a new home at Shell Mex House on the Strand, less than a mile away from their wartime digs on Old Queen Street. The change also coincided with new leadership: Lord Portal, formerly Marshal of the Royal Air Force, was appointed to oversee the new organisation. The first meeting of Portal's technical committee was devoted primarily to discussions as to 'the most efficient and quickest way of getting production of fissile material started on a scale that would be militarily significant'. [32] Oliphant, present at the meeting and as willing as ever to plough an independent furrow, took issue with the emerging consensus around graphite pile construction, arguing that if speed were truly of the essence, a programme of uranium enrichment – about which the British already knew a great deal – would be preferable.[33]

[23] Smyth, *Atomic Energy for Military Purposes*, pp.vi, 53, 70-71, 190
[24] Akers to Auger, 6th November 1945, AB 1/54 (TNA)
[25] Akers to Rickett, 29th August 1945, AB 1/54, and *cf*. Akers to Brabazon, 1st September 1945, AB 1/54 (TNA)
[26] Rapkine to Akers, 22nd September 1945, and reply, AB 1/54 (TNA)
[27] 'Britain and the Atomic Bomb', August 1945, AB 1/54 (TNA)
[28] Howe to Editors, undated (pre-13th August), AB 1/54 (TNA)
[29] 'Canada's Role in Atomic Bomb Drama', 13th August 1945, AB 1/54 (TNA)
[30] Smyth, *Atomic Energy for Military Purposes,* p.295; 'Canada's Role in Atomic Bomb Drama', 13th August 1945, AB 1/54 (TNA)
[31] 'Canada's Role in Atomic Bomb Drama', 13th August 1945, AB 1/54 (TNA)
[32] Portal to Chadwick, 26th April 1946, AB 1/354 (TNA)
[33] Ibid.

In Canada, meanwhile, policymakers who had previously been uninformed of the nuclear programme had suddenly to comprehend both the topic itself and Canada's role within it. As Buckley has noted, the extremely limited dissemination of information within the Canadian government meant that almost nobody was in a position to think through the long-term implications for Canada.[34] Senior policymakers were left guessing, even in policy papers, as to the extent of Canada's engagement with the Anglo-American programme,[35] and one of the diplomats most closely concerned, Hume Wrong, had to resort to sending Mackenzie a list of questions which he confessed read 'rather like an examination paper'.[36] Wrong's questions included the extent of British and American dependence on Canada, the 'absolute and relative importance of Canada's part in the development related to the employment of the atomic bomb' (encompassing raw materials, research, development, manufacturing, and finance), and the 'potential importance' of the technology to Canada's future position in global affairs.

Even if her diplomats were ignorant, Canada enjoyed one asset which her allies lacked: continuity of leadership. In Britain and the United States alike the problems of the future – those posed by the bomb, and those external to it – were to be faced by new governments still finding their feet. Harry S. Truman and Clement Attlee had both come to power before shortly the end of the war. Truman's programme was perforce a continuation, for the most part, of his predecessor's, but Attlee's Labour government proposed to follow a radically different programme in almost every area of policy. What that would mean for the British nuclear programme was, however, unclear: there had scarcely been time to formulate a cogent policy. With the advent of peace Attlee was able to give the matter deep thought. His oft-quoted assertion, in a memorandum of 28th August, that 'only a bold course can save civilisation' has often been read as idealistic, with British post-war policy consequently cast as a process of gradual disillusionment as initial utopian enthusiasm for international control faded into a grudging acceptance of the 'necessity' of an independent programme.[37] Closer attention to Attlee's analysis, however, shows that the policy was shaped by desperation, rather than idealism: Britain, 'the heart of the Empire', was now supremely vulnerable. This was 'the one fact that matter[ed]', for unless Britain's own safety could be secured, it would be 'no use bothering about things on the periphery'.[38] This was, to some extent, an inversion of traditional imperial strategy, which held that Britain's primary interests lay in the preservation of key imperial possessions and the routes between them. Whether Britain's salvation lay in nuclear weapons or in the hope of international control, it was clear to Attlee that there must be discussions with the Americans as soon as possible. He resolved to engineer a discussion with Truman, composing a lengthy and thoughtful letter – to which the Americans did not initially respond.[39] A follow-up telegram precipitated a slightly terse correspondence in which the British desire for direct talks was made explicit.[40] Mackenzie King approved of Attlee's initial approach to Truman; he privately described it as 'one of the best letters I have ever read'.[41] He shared

[34] Buckley, *Canada's Early Nuclear Policy,* p.37; Robert Bothwell, *Eldorado: Canada's National Uranium Company* (Toronto: University of Toronto Press, 1984), p.159
[35] Memorandum, 21st September 1945, *DCER*, Doc.616
[36] Wrong to Mackenzie, 22nd October 1945, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 2' (LAC)
[37] The Atomic Bomb: Memorandum by the Prime Minister, 28th August 1945, Gen 75/1, PREM 8/116 (TNA)
[38] Ibid.
[39] Attlee to Truman, 25th September 1945, PREM 8/117 (TNA)
[40] Attlee to Truman, 12th October 1945, PREM 8/117 (TNA); Attlee to Truman, 16th October 1945, PREM 8/117 (and surrounding) (TNA)
[41] J.W. Pickersgill and D.F. Forster, *The Mackenzie King Record*, *Volume 3: 1945-1946* (Toronto: University of Toronto Press, 1970), p.58

Attlee's views as to the desirability of keeping the Commonwealth fully informed, differing only on the question of precisely when that should be.[42] The backing of the Canadians was of great value to Attlee in his approach to Truman: it was helpful to be able to mention that he had already discussed the matter with Mackenzie King, and to stress the unison of their views.[43] At the same time, British internal documents reveal their understanding of the need to handle the Canadians with care. One note cautioned, 'On imperial grounds', that

> it is most desirable that Mr. King should feel that we treat him with at least as much confidence as we treat the Americans or the Americans treat us. It is also desirable that Mr. King should draw his ideas as to the handling of atomic energy from us rather than from the Americans.[44]

A contemporaneous note by Attlee's Foreign Secretary Ernest Bevin similarly observed that it would be 'useful if you could get Mackenzie King into line first'.[45] This paradoxical position of viewing the Canadians both as independent partners and as pliable subordinates is indicative of the liminal stage which Anglo-Canadian relations had reached. The British had now to acknowledge the relationship with Canada as an alliance to be fought for, rather than a vassal to be taken for granted. Yet the very fact of Attlee's having met with Mackenzie King in advance of the meeting with Truman speaks also to the lingering significance of the Commonwealth connection.

The other Dominions, lacking Canada' privileged position within the nuclear fold, were informed rather than consulted. Copies of Attlee's correspondence with Truman were only forwarded to the other Dominion Prime Ministers on 17th October, with a promise that they would be kept posted on any further developments.[46] The Australians were particularly keen that this should be the case. Chifley telegrammed Attlee on 8th November:

> I regard the discussions which you are to have in Washington on the Atomic Bomb as most important and I would like to be kept informed. As you know, Australian scientists made [a] contribution and we should like to share in the decisions which might be taken as to the future use of the knowledge which has been acquired[47]

This desire to 'share in the decisions', advocated on the basis of an Australian contribution, has echoes of Rivett's wartime policy of leveraging Australian assets to achieve access to information. Indeed, the Australians were not wholly content simply to be informed in retrospect of the outcomes of the discussions: in the same message, Chifley noted that H.V. Evatt, his Foreign Minister, would be in Washington at the time of Attlee's visit, and hoped that he might therefore be brought into the conversation. The British were

[42] Attlee, 12th October 1945, PREM 8/116 (TNA)
[43] Attlee to Truman, 16th October 1945, PREM 8/117 (TNA)
[44] 'International control discussions' etc.; 5th October 1945, PREM 8/116 (TNA)
[45] Bevin to Attlee, 24th October 1945, PREM 8/117 (TNA)
[46] PM to Aus/NZ/SA PMs, 17th October 1945, PREM 8/116 (TNA)
[47] Chifley to Attlee, 8th November 1945, PREM 8/117 (TNA)

unmoved: there seemed to be an 'insuperable difficulty' in actually bringing Evatt into the tripartite discussions,[48] and no appreciable effort seems to have been made in that regard.

In terms of resolving the future of allied nuclear co-operation, the Washington meeting ultimately achieved very little. Beyond a public declaration and a three-point secret agreement, the only tangible product was a memorandum, composed and signed by Groves and Anderson, comprising recommendations for the CPC to consider as the basis for a 'new document' to replace the Quebec Agreement, 'which should be superseded in toto'.[49] The historian Greg Herken casts the Groves-Anderson memorandum as 'a masterpiece of ambiguity', intended only as a prompt for some future substantive negotiation.[50] This was certainly the British understanding of the document,[51] though it was hoped and expected that those negotiations would be moulded by the spirit of the memorandum rather than the letter.

This expectation was put to the test at the CPC meeting held in February 1946, the primary purpose of which Dean Acheson, one of the American participants, saw as being to recast the Quebec Agreement. It was first agreed that the contentious fourth clause would be best dealt with through an exchange of letters between the President and the Prime Minister, drafts of which were agreed. Attention then turned to a draft memorandum of agreement, based, as the British had hoped, upon the Groves-Anderson memorandum. Its key features were its tripartite character – elevating Canada from its previously ambiguous position – and commitments neither to use the weapon against other parties without prior consultation, nor to disclose information to 'other governments or authorities or persons in other countries' except as part of agreed policy or after prior consultation. This last point was somewhat ambiguous in its implications for Commonwealth interactions, although the Americans' reading would certainly have prohibited them. The suggested agreement also required each government to take steps to secure control and possession of uranium and thorium resources within their individual territories, which for the United Kingdom included its colonial dependencies. When it came to relations with the Dominions there was, however, a departure from the formula under which the CDT had previously operated. The proposed agreement contained a commitment that the parties would 'severally or jointly use every endeavour with respect to the remaining territories of the British Commonwealth and other countries' to secure supplies.[52] In this case the UK would no longer have absolute priority in nuclear material negotiations with the Dominions.

This change had not been to Anderson's taste: of the various (mostly minor) changes he proposed to the sub-committee's draft documents in the lead up to the CPC meeting, the most substantive was a request that the reference to 'the remaining territories of the British Commonwealth' should be deleted.

> It would be improper on constitutional grounds to refer in this way to action to be taken in respect of Commonwealth countries about which they had not been previously consulted. The phrase "other countries" includes the British Empire, and it is, of course, to be clearly

[48] Rowan to Attlee, 10th November 1945, PREM 8/117 (TNA)
[49] Groves-Anderson Memorandum, 16th November 1945, CAB 130/3 (TNA)
[50] Greg Herken, *The Winning Weapon: The Atomic Bomb in the Cold War, 1945-1950* (New York: Alfred A. Knopf, 1980), p.65
[51] Draft Telegram, December 1945, CAB 130/3 (TNA)
[52] CPC, 15th February 1945, AB 16/4840 (TNA)

> understood that action in respect of the Commonwealth countries will be taken by us. If necessary we can exchange letters to this effect.[53]

The effort seems to have failed, however, and Anderson's opposition to the new formulation was weakened somewhat by the fact that wording to the same effect had been present in the original Groves-Anderson document. It mattered little, however: no agreement was reached on a replacement for Quebec. The greatest impediment to a new agreement turned out to be the very architecture of world order to which the United Nations had so emphatically committed. It had been supposed that any new agreements to replace Quebec and the Declaration of Trust could be kept secret, but the Americans now seemed increasingly certain that such commitments must be published. This might not be a disaster: it might be 'wholesome' for the United States 'to commit itself publicly to this specially intimate collaboration with the Canadians and ourselves'.[54] The likely charge of hypocrisy would, however, present an almost insuperable obstacle to this course of action: to make such commitments publicly in the context of ongoing negotiations for international control would be to hand the Soviets an immediate propaganda gift. The answer, then, was to proceed on the basis of the old agreements, amending them where necessary through the mechanism of the CPC. Acheson wrote later of his disquiet at the sense that 'having made an agreement from which it had gained immeasurably, [the United States] was not keeping its word and performing its obligations'.[55] At the time, though, neither he nor his colleagues took any particular action to mitigate the effects of such an approach.

Britain and Canada Adjust to the New World

One thing that was abundantly clear in the months after Hiroshima was that the early Cold War nuclear landscape – the 'New World' about which Hewlett and Anderson would write – belonged utterly to the Americans. It was a fact to which both the British and the Canadians must adapt. The two countries, however, adapted at different paces and in different directions, and in so doing were forced also to alter their conceptions of their own nuclear relationship.

A British assessment of Canada's position in early October 1945 confessed that it had hitherto been 'a little anomalous'. Canada had made important contributions both in terms of raw materials, and in financing, hosting and staffing research and development work. She was not a party to the Quebec Agreement, but was nevertheless represented on the CPC and CDT. Public statements made since Hiroshima had meanwhile treated Canada 'as a full partner in the enterprise'.[56] This progressive elevation of Canada to full partnership was broadly welcomed by the British:

> The conception that Canada is in every sense an equal partner with us and the U.S.A. has grown up naturally in spite of past anomalies and is basic to any future discussions. This is greatly to our advantage both from the scientific standpoint and also politically.[57]

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[53] Anderson to PM, 9th February 1946, CAB 130/3 (TNA)
[54] Minute to PM from Foreign Office, 27th February 1946, CAB 130/3; Halifax and Wilson to Anderson, 19th February 1946, CAB 130/3 (TNA)
[55] Dean Acheson, *Present at the Creation: My Years in the State Department* (London: Hamish Hamilton, 1969), p.164
[56] Rickett to Rowan, 5th October 1945, PREM 8/116 (TNA)
[57] Ibid.

A consequence of this new conception of Canada-as-partner, though, was that the Canadian government would require increasingly careful handling, and in the months following Hiroshima the British were alive to opportunities for immediately realisable adjustments to the tripartite collaboration. The Canadians themselves now felt the administrative absurdity of the Canadian representative on the CPC being treated as part of a three-man British grouping: the appointment of a Canadian joint secretary proved an easily agreed solution.[58] Less straightforward was the wider question of representation, for it remained unclear whether the CPC would be reformed or replaced. Either way, the Canadians hoped (and the British agreed) that Canada should adopt a greater role – whether as signatory to a new agreement, or as an equal participant in whatever became of the CPC. Canadian attitudes to the CDT were more complex. In December 1945 Howe expressed a strong desire to distance Canada as far as possible from the Trust's operations, and certainly from any financial commitment thereby.[59] Howe's unlooked-for critique of the CDT was undermined somewhat by his 'cloudy comprehension' of its original basis,[60] but was coherent at least in its rejection of anything that might impinge on Canada's peacetime position as the allies' leading uranium supplier. A British proposal that 'in the case of any material produced in any Empire country which might be sold to the Trust, the sale in the first instance should be to the U.K., and from the U.K. to the Trust' consequently met short shrift, and never made it to deliberation by the full CPC.[61] The Canadians, meanwhile, acknowledging that the CDT proceeded from the CPC, ultimately accepted the necessity of participation in both.

Aside from these procedural issues, the advent of peace had left the Canadians acutely conscious of the new position in international affairs which their possession of both exportable uranium and the only substantial nuclear facility outside the United States afforded them. There were three obvious consequences: Canada's importance to the United States had grown exponentially; she must now expect to attract more attention from the Soviet Union; and her relationship with the wider empire must also be expected to change. For the time being, Canada possessed the Empire's only nuclear pile – a potentially exploitable asset. Mackenzie certainly thought so. Relishing Canada's 'very strong cards' relative to the United Kingdom, he hoped that the United Kingdom might decide against their proposed expenditure on a large-scale programme in Britain in favour of establishing

> a large Commonwealth plant in Canada, which could supply the material for the other parts of the Empire, and to the research laboratories of which teams from the various Dominions and Britain could come for research work.[62]

If a decision could be made in favour of keeping Chalk River as the main focus of British work, 'It would mean that the heart of the war-making power of the British Commonwealth was located in Canada.'[63] The

[58] Memorandum, 11th October 1945, *DCER,* Doc.618*;* Ambassador in United States to Secretary of State for External Affairs, 13th October 1945*, DCER,* Doc.619*;* Rickett to Rowan, 5th October 1945, PREM 8/116 (TNA)
[59] Secretary of State for External Affairs to Ambassador in United States, 3rd December 1945, *DCER,* Doc.640; Howe to Bateman, 11th December 1945, *DCER,* Doc.647; and *cf.* discussion in CAB 130/3 (TNA)
[60] Bothwell, *Eldorado*, p.177
[61] Bateman to Howe, 7th December 1945, *DCER,* Doc.646
[62] Quoted in Holmes, *The Shaping of Peace*, pp.217-218; *cf.* RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 2' (LAC)
[63] Memorandum, 6th November 1945, *DCER,* Vol. 10, Doc.628

Canadian relationship with the British Empire might, by this point, have become fiercely ambivalent, but there was still some appeal in the idea.

Mackenzie's was not an irrational hope, for in the first months of peace British plans remained in a state of flux, and a reasonable case could be made for keeping Chalk River as the focus of British efforts. Chadwick, considering the matter in September 1945, adopted the following logic. It seemed 'essential for the defence of the United Kingdom and the British Commonwealth' that Britain should have a production plant of its own. The need to produce weapons 'as quickly as possible' meant that the plant should be orientated to plutonium production.[64] This, in turn, would mean that projects oriented towards uranium enrichment, such as the diffusion or electromagnetic methods, should effectively be ignored, and instead, a graphite pile comparable to the Americans' should be constructed; and if speed were really the priority, the pile should be water-cooled, which in turn meant, in Chadwick's view, that it should located on the Canadian site.[65] 'I realise', wrote Chadwick, 'that this proposal will meet with strong objection from some quarters, and naturally so'; he was at pains to stress that he proposed Canada as the location 'only for the first pile… I would make no commitments whatever about subsequent piles or other plants'.[66]

Chadwick's reluctant logic was sound on the level of general principle but failed under more granular consideration. Cockcroft, giving a technical appraisal of the idea, noted that the design work would still need to be done in the United Kingdom, owing to the lack of appropriate personnel in Canada, and that it would be better – not least for dollar economy – that manufacture of engineering parts be conducted in the UK. On the other hand, the civil and chemical engineering work could all be done in Canada without need for any additional personnel.[67]

The debate over the extent to which Chalk River might serve as a Commonwealth endeavour and the entire tone of post-war Anglo-Canadian nuclear relations were both irrevocably shaped by one particular incident: the withdrawal of Cockcroft from Chalk River to take up the directorship of the new research establishment at Harwell. The idea had clearly had a long incubation. Although Cockcroft's appointment to Chalk River had initially been envisaged as outlasting the war, he had participated in many of the AERE site visits in the spring of 1945. His initial appointment had been very dear to the Canadians, and misgivings over Canadian reactions to his withdrawal within a year would have been more than justified. Chadwick, for one, demurred; he doubted that Howe would take kindly to Cockcroft's departure, and anyway felt that Cockcroft would, for the time being, be of greater use in Canada, with the work at a crucial stage, than in the United Kingdom, where little had yet been prepared.[68] His warning appears to have gone unheeded, however, for by September the formal offer of the directorship of Harwell had been made. This presented Cockcroft with 'a very difficult decision', not so much because he should have to leave Canada but because he had been looking forward to returning to Cambridge. This, at least, was how he expressed himself to Anderson, whilst acknowledging that 'the National Interest should come first' and that he would, therefore,

[64] Chadwick to Rickett, 10th September 1945, AB 1/381 (TNA)
[65] Ibid.
[66] Ibid.
[67] Cockcroft to Portal, 11th January 1946, AB 6/14 (TNA)
[68] Chadwick to Rickett, 31st August 1945, AB 1/381 (TNA)

be likely to accept – albeit with a number of stipulations, including that he should have a voice on policy.[69] Cockcroft, in common with many of his junior colleagues, had chafed against the strictures of wartime security, and he had told Anderson that he would have declined the directorship if the establishment were to enforce secrecy on the wartime pattern.[70] Assured otherwise, Cockcroft confirmed to Mackenzie on 3rd December both that he had been offered the role and that he intended to accept.[71]

The immediate impact of this step was a catastrophic degradation of Anglo-Canadian nuclear relations. The Canadians had good reason to feel aggrieved. It was not simply the loss of Cockcroft, but what they feared that loss symbolised: withdrawal of British interest and rejection of Canadian partnership. In October 1944 the Canadians had expressed some disquiet about the possibility that the British might unilaterally withdraw their staff from Montreal after the war, and had received assurances from Anderson, via Chadwick, that Britain would 'continue to collaborate with Canada on this project after the war'.[72] Such assurances now seemed rather hollow.

The die, however, was cast. A crumb of consolation was available to the Canadians in the British commitment that Cockcroft would remain in post at Chalk River until a successor had been appointed. This was not to be mere time-serving: Cockcroft continued to work diligently on long-term projects for Chalk River throughout this period, writing a paper on future piles in April 1946, in which he envisaged several possible pile configurations, all requiring either US or British support.[73] Still, the wound festered.

In October 1945 the British thought it apt, in light of their intentions around the AERE, to make a statement in the CPC describing their plans, clarifying their desire for continued collaboration and explicitly their desire for full co-ordination with the Canadian project.[74] Forewarned of this statement by the British as an ordinary courtesy, the Canadians, still in the throes of pique over the planned withdrawal of Cockcroft, prepared a somewhat intemperate statement with which their representative should respond:

> Canada offers no objection to the proposed programme, but since the programme involves withdrawal from Canada of scientists presently directing the Chalk River project, Canada considers that the partnership arrangement as between the United Kingdom and Canada previously recorded in the Minutes of the Combined Policy Committee will be ended with the withdrawal of these men.[75]

It was to be made clear that whilst UK personnel would be welcome as occasional guests, and whilst the Canadians hoped for reciprocal treatment at the UK establishment, this would no longer be a joint project. The threat was never actually carried through – the Britons on the ground having managed to mollify the Canadians sufficiently – but Howe and Mackenzie were 'evidently still resentful', not just of Cockcroft's

[69] Cockcroft to Anderson, 17th September 1945, AB 27/1 (TNA)
[70] Cockcroft to Anderson, 10th October 1945, AB 27/1 (TNA)
[71] Cockcroft to Mackenzie, 3rd December 1945, AB 27/1 (TNA)
[72] Chadwick to Mackenzie, 16th October 1944, & *cf.* Laurence to Mackenzie, 9th November 1944, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 1' (LAC)
[73] Cockcroft, 'Future Piles at Chalk River', 22nd April 1946, AB 2/125 (TNA)
[74] Rickett to Rowan, 5th October 1945, PREM 8/116 (TNA)
[75] Howe to Pearson, 14th February 1946, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 2' (LAC)

appointment to Harwell, but also 'the fact that they have not been brought into consultation over [the British programme]'; Reports from Washington meanwhile indicated that the US War Department thought it best, 'for strategic reasons' that the British pile should be located in Canada.[76]

Anderson rightly acknowledged these developments in the Anglo-Canadian relationship as 'rather grave', though from his perspective somewhat unjustified, since he had earlier assured Howe of Britain's 'continuing interest in the Canadian pile and gave him an assurance that in the matter of Cockcroft's successor, [Britain] would not let him down'.[77] Cockcroft had not yet been withdrawn, nor had many others of the British staff; those who had left were those who had completed their agreed terms of service, and who could not, now that the war was over, be compelled to stay. As to the statement of plans, the British intention had clearly been misconstrued: the whole purpose of making a statement in the context of the CPC was to permit comment and appraisal. Reassurances were swiftly offered. The message was to be shared that 'the decision to build a pile here to meet our own requirements in no way implies that we reject the idea of a similar development, possibly on a Commonwealth basis, in Canada'.[78]

This statement may have been a sincere after a fashion, but as ever the UK dollar position militated strongly against the idea that there should be further substantial expenditure in Canada. For the Britons seeking to comprehend the Canadians' irritability in all this it was almost sufficient to note, as the High Commissioner did, that 'Howe is an extremely tired man', and that circumstances had combined to foster a profoundly negative mood in him.[79]

> It will no doubt be agreed that we should continue to give as much support as we can to the Canadian project and any further developments in Canada, if only in interests of maintenance of full co-operation with Canadians. If Canadian activities can be given a fuller Commonwealth character so much the better[80]

The appointment of Cockcroft's successor was itself a fraught task. The Canadians were insistent that the appointment should be made by themselves alone, and strongly preferred that a Canadian should be chosen. The British had no choice but to acquiesce: the withdrawal of Cockcroft and the return home of British staff meant that Chalk River was by now an essentially Canadian establishment. Recognition of such niceties required a degree of mental readjustment on the part of the British government. The original draft of the Prime Minister's statement to the House of Commons noted that Cockcroft was 'at present acting as Director of the experimental atomic energy plant in Canada', and that he would remain there 'pending the selection of a suitable successor'.[81] Fortunately, someone was canny enough to realise that this was 'not altogether happily drafted', not least since it implied that the selection of a successor lay in British hands.[82] Staff in Washington likewise stressed Canadian sensitivities, insisting that any announcement would require their consultation.[83]

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[76] Halifax and Wilson to Anderson, 17th February 1946, CAB 130/3 (TNA)
[77] Anderson to Halifax and Wilson, 23rd February 1946, CAB 130/3 (TNA)
[78] Ibid.
[79] Canada MacDonald to Anderson, 25th February 1946, CAB 130/3 (TNA)
[80] Ibid.
[81] DO to Canada Acting HC Ottawa, 16th January 1946, PREM 8/1554 (TNA)
[82] [High Commissioner's Office] to Cockcroft, 17th January 1946, AB 27/1 (TNA)
[83] Makins and Chadwick to Rickett, 17th January 1946, PREM 8/1554 (TNA)

Deference to Canadian sovereignty over the appointment did not absolve the British of interest in the search. It was very much in British interests that the right candidate be found, and the British government had anyway promised to assist in the search for a qualified replacement. An appropriate candidate, W.B. Lewis, was soon identified, and Chadwick was asked to sound out Mackenzie as to whether he might be acceptable to the Canadians.[84] Mackenzie was reportedly 'somewhat lukewarm' about Lewis.[85] More worrying still, the search for suitable Canadians seemed to have taken a very unfortunate turn. Canada's limited pool of experienced scientific leaders had led to the net being cast rather too widely. Some months previously, Mackenzie and Howe had asked Groves for suggested replacements if Cockcroft were to leave. Groves had recommended two Canadian-born naturalised Americans, Thornton and Zinn.[86] Mackenzie was 'much impressed' with Zinn, who swiftly became the front-runner.[87]

Troubling though this was, the British were now at pains to declaim any idea that they sought unduly to influence the Canadians' appointment processes: 'In bringing forth the name of Lewis… we were not attempting to force their hand but we were offering our help by finding the most suitable man in England who was available for the post.'[88] Cockcroft, keeping a keen eye on the process, reported back that

> There appears to be no suitable Canadian citizen available and whilst there are possible candidates amongst the Canadians who have taken U.S. citizenship [*i.e.* Zinn and Thornton], it would be against our interests if such an appointment were made, since we desire to retain the closest ties with the Chalk River Laboratories[89]

The risk that the Canadians might put an American citizen at the head of the Chalk River project appalled Anderson, too; he was reportedly in favour of any steps that Chadwick or Cockcroft could take to put pressure on the Canadians to accept Lewis instead.[90] The grounds for this opposition to the appointment of an American were, as Cockcroft intimated, the fear that such a step would preclude the continuation of close ties between Harwell and Chalk River. An American would presumably orient Chalk River towards the United States rather than the nascent development programme in the United Kingdom. This risk was mitigated slightly by the quality of the leading candidate, Zinn, whom Cockcroft, glossing over the matter of Zinn's new American citizenship, had described as 'Probably the best of the Canadian physicists abroad'.[91] He and Chadwick were in fact both 'favourably impressed' with Zinn, whom they thought would be 'a reasonably satisfactory choice'.[92] Providence, however, favoured the British cause: although an offer was made to Zinn, he chose not to accept. (Mackenzie suspected the Americans had had repented of their earlier suggestion and put pressure on him to remain in the United States.)[93] This left the way open for Lewis, whom Cockcroft was encouraged (tactfully) to urge on the Canadians.[94] In the absence of a suitable

[84] Akers to Chadwick, 12th February 1946, AB 16/268 (TNA)
[85] Chadwick to Akers to Franks, 14th February 1946, AB 16/268 (TNA)
[86] CJM diary, 13th November 1945
[87] CJM diary, 13th April 1946
[88] 'Meeting with Mr C.D. Howe on March 23rd 1945', AB 1/193 (TNA)
[89] Cockcroft to Sec. D.At.En, 7th February 1946, AB 16/268 (TNA)
[90] [Rickett?] to Dow, 22nd February 1946, AB 16/268 (TNA)
[91] Cockcroft to Smith, 13th March 1946, AB 27/7 (TNA)
[92] Canada MacDonald to DO/Halifax, 27th March 1946, AB 16/271 (TNA)
[93] Mackenzie to Keys, 1st October 1947, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 2' (LAC)
[94] Franks to Cockcroft, 16th May 1946, AB 1/596 (TNA)

'Canadian' candidate, Mackenzie had little choice. Lewis was the successful candidate, and Britain the ultimate beneficiary.

The whole affair had propelled Anglo-Canadian nuclear ties into new realms of awkwardness. Lingering Canadian resentment over the handling of Cockcroft's transfer to Harwell became the new backdrop to discussions between the two countries, which at times resembled a salvage operation on the part of the British participants, who sought rather frantically to reassure the Canadians of Britain's continued support in the nuclear realm. Consider, for example, the meeting of 23rd March 1946, intended primarily to assure Howe of Britain's continued interest in the Canadian project. He was told that a substantial British team would remain at Chalk River, including senior personnel, with a corresponding hope that Canada 'would help to make collaboration closer and more profitable to us both by sending a team to Harwell'.[95]

> The discussion brought out the apprehension in the minds of Howe and Mackenzie that we wanted some control over the Canadian project, beyond that provided through the mechanism of the C.P.C. We disclaimed any intention of this kind, agreeing that the Chalk River Project was essentially a Canadian undertaking, although it had taken shape from a joint endeavour in the setting up of the Montreal Laboratory. We pointed out a general analogy between this project and our own Harwell Establishment[96]

This was a far cry from the original dynamic of Anglo-Canadian nuclear research. What had begun as a British-led project in Canada had become a wholly separate establishment with which Britain simply had strong ties. The High Commissioner's account of the same meeting casts further light. Although Howe and Mackenzie began by arguing that Cockcroft's withdrawal had removed the basis for Anglo-Canadian co-operation, his appointment having been foundational to the Canadian government's commitment to the project, they were eventually mollified to the point that they could accept British assurances:

> They said that provided we would continue to furnish them with a number of good men and to accept the position that the administration of the Canadian project was a wholly Canadian matter, they would be satisfied and would be glad to co-operate on the same basis in our undertaking and to regard both as part of a co-ordinated Commonwealth effort.[97]

Throughout these discussions Howe and Mackenzie made much of their insistence that British staff should be answerable to the Canadian authorities, despite the fact that this was effectively the existing state of affairs. Fear of further withdrawals of UK staff must account for most of this fixation, though bad memories of poor relations in the Halban era cannot have helped. At the same time, there was a notion that the United States might view Canada as a more important partner than the United Kingdom,[98] reflective of a hardening of Canada's latent empathy for the American perspective into a more explicit sense of North American solidarity. The Canadians were not therefore particularly supportive of British efforts to secure collaboration with the United States. Much depended upon the interpretation of the phrase "full and

[95] 'Meeting with Mr C.D. Howe on March 23 1945', AB 1/193 (TNA)
[96] Ibid.
[97] Canada MacDonald to DO rep Halifax, 27th March 1946, AB 16/271 (TNA)
[98] Bateman to Howe, 10th August 1945, *DCER,* Doc.607*;* Howe to Bateman, 17th August 1945, *DCER*, Doc.608

effective co-operation" which the tripartite discussions in Washington had promised, and the British pressed the Canadians for their construal, in the hope that this would align more closely with the British than the American. The Canadian answer was carefully phrased and far from helpful; in fact, it side-stepped the question altogether.[99] The evasion was very much the point. The Canadians were at particular pains to avoid furnishing the British with ammunition that might precipitate rash action; hence the scrupulously inoffensive response that 'we felt that a direct and simple statement of the way in which Canada had acted throughout in these matters would be the most helpful contribution'.[100] Canada, in short, was unwilling to pick sides. That is not to say that they were indifferent to the progress of the negotiations. The Canadians were clearly concerned that the emerging Anglo-American breach should not widen, not least for the deleterious impact it would have on international relations: 'if it could not be patched up, [it] must be covered up, or [the] effect on world opinion would clearly be disastrous'[101] It did, however, mean that Commonwealth loyalty was not so great as to override Canada's other interests. The war had proven that the Canadian voice in allied nuclear affairs was not merely an echo of the British, and the consequences were now being felt in peacetime.

The saving grace for the British was that the essential connection between Chalk River and Harwell was preserved, and that the interpersonal relationship between Cockcroft and Lewis remained strong. As well as exchanging formal reports the two directors corresponded freely with one another, and Lewis felt sufficiently comfortable in his position to have ventured, as a 'general criticism', his view that

> the U.K. policy seems to me very insular. Can't you depend on the Commonwealth to co-operate? I cannot yet speak as a representative Canadian but I would expect Canadians, if they knew, to feel rather left in the cold. Must <u>all</u> the preliminary work be done in the U.K. to start the world fires of fissile 23?[102]

He did, however, exempt Harwell-Chalk River co-operation from this critique (he thought it 'very satisfactory on both sides').[103] Various other forms of interaction also persisted between the two establishments. On metallurgy, Cockcroft wrote to Mackenzie about his desire 'to see that the field is covered without too much overlapping'.[104] It was agreed in a meeting between Howe, Mackenzie, Chadwick and Cockcroft that 'interchange of staff should continue'. There were to be two categories of interchange: short visits for specific tasks, and longer stints (of greater than one year) for general work. Three months' notice was to be given of any withdrawals. Salaries and expenses for British personnel in Canada were to be paid by the United Kingdom, and there was to be an agreed schedule for moves. The overall number of British-employed personnel in Canada would fall, from 67 in October 1946 to 30-40 by March 1947, to settle at a consistent level of only 15-20 in the latter stages of the year. It was meanwhile expected that as work develops in the Harwell Establishment, arrangements would be made for some secondment of Canadian staff. They also identified a number of items 'of joint interest' in the Chalk River

[99] Canada Govt to DO / PM to PM, 1st May 1946, PREM 8/367 (TNA)
[100] Canada Govt to DO / PM to PM, 1st May 1946, PREM 8/367 (TNA)
[101] Canada Acting High Commissioner Ottawa to Sec State Dominion Affairs repeated for Halifax, 28th April 1946, AB 16/271 (TNA)
[102] Lewis to Cockcroft, 6th December 1946, AB 6/131 (TNA)
[103] Ibid.
[104] Cockcroft to Mackenzie, 10th July 1946, AB 1/187 (TNA)

experimental programme, including research on a continuous process for extraction of plutonium, and confirmed the various steps thus far taken to co-ordinate (there were not very many: material testing and metallurgical discussions regarding beryllium). A future development programme was discussed, to include various pile types (a low power/100kw plutonium homogeneous reactor; a high temperature beryllia/graphite moderated reactor; a high temperature liquid metal cooled fast reactor; and a U-235 breeder study pile). 'It would seem desirable', they agreed, 'to divide this development programme between the two establishments according to the facilities and resources'. Interchange of information was to cover all technical reports, technical committee meeting minutes, monthly and bi-monthly progress reports, and small-scale equipment exchanges were to be facilitated. There were plans, too, for the interchange of materials including British-sourced uranium for NRX from January 1948 (approximately 10 tons per year); 600g plutonium for Harwell for experimental work from 1948 to 1950; and plutonium from the UK to Chalk River for pile development once UK production was established (anticipated in about 1950). This, it was noted, 'would no doubt require agreement at high level between the two Governments'.[105] In short, a very comprehensive process of co-ordination and interchange was envisaged, with the clear objective of accumulating fissile material for the United Kingdom and amassing relevant knowledge and experience for both parties. A memorandum produced in Harwell that September summarised the aspiration:

> It is the earnest hope of the U.K. Atomic Energy Establishment at Harwell that the Canadian and British projects be so closely in touch that an agreed research and development programme can be arranged to avoid duplication and waste of effort and public funds, and this applies particularly in the engineering field.[106]

There were, however, limits to the extent of interchange. A suggestion in December 1946 that certain internal reports might be made available to the Canadians was scotched, arguing that 'no useful purpose would be served by sending reports of domestic difficulties which would not be fully appreciated by the Canadians'.[107] *Pas devant les enfants?* There was confusion, too, about the obligation of the Canadians to contribute to the design of the UK chemical plant, stemming from cases where it had been expected in the UK that work would be done in Canada, but for which the Canadian teams had not planned. It was established that the design work properly resided in the UK, and that the only expectation of the Canadians was the supply of relevant information, and even then, only on areas of mutual interest: 'the present program is undoubtedly limited to the common phases of the work, that is, to those problems which are of common interest to the U.K. and Canada.'[108] The UK staff at Chalk River could be tasked with the collection and transmittal of information already available at Chalk River, whilst information of mutual interest could legitimately be performed by the Canadians, and would be passed to the United Kingdom as a matter of course. Work of relevance only to the British programme was, however, notionally impermissible – though here the minutes betray an expectation that such work might, at British request, be performed, with a letter from Cockcroft to Mackenzie envisaged as the only required formality.

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[105] Cockcroft, 'Co-operation in Atomic Energy Between Canada and the United Kingdom', 10th September 1946, AB 16/69 (TNA)
[106] Memo by Tongue, 'Suggested re-organization of the engineering branch at Chalk River…', 18th September 1946, AB 2/128 (TNA)
[107] Atomic Energy Council Minutes, 15th Meeting, 18th December 1946, AB 41/622 (TNA)
[108] 'Minutes of a meeting… to discuss the programme of chemical engineering work on plutonium extraction', 29th October 1946, AB 6/131 (TNA)

A Role for the Dominions?

Of all Britain's Commonwealth relations in the nuclear realm it was Canada that mattered most to British plans; even the awkward process of adjustment and dissociation described above could not alter that fundamental fact. Yet that is not to say that the other Dominions were an irrelevance in this period. Quite the opposite: the liberating effect of peace and the perceived urgency of Britain's nuclear programme inclined British and Dominion policy-makers to embrace new or renewed opportunities for collaboration and exchange, and even seemed, for a brief moment, to offer an opportunity for a coherent Commonwealth programme. As had been the case during the war, the individual experiences of the Dominions differed significantly from one another, primarily in consequence of their differing contexts. Prior wartime interactions influenced but did not wholly determine these experiences: South Africa, for example, figured far more prominently in British nuclear thinking in 1945-6 than its limited engagement with nuclear developments during the war would have foretold. The purpose of this section is to determine what role, if any, it was considered that the Dominions might play in British nuclear research and development, and to trace the decisions made.

The governments of Australia, New Zealand and South Africa had all received some degree of indoctrination into the nuclear secret, but this was certainly not as extensive as Britain, or the Dominions, might have liked. Gowing was stretching things somewhat in suggesting that 'The Australian and New Zealand governments knew nothing',[109] but it is true at least that the Dominions had not been told as much as either they or the British would have chosen. In a post-war strategic environment informed above all by Britain's desire to make rapid progress on nuclear development, the UK looked instinctively to the Commonwealth to fulfil various roles, the most crucial of which was in the provision of raw materials. It was becoming increasingly obvious that Canada could not produce uranium in sufficient quantities to meet Britain's projected needs, so it made sense to look elsewhere;[110] and the uniquely privileged position Britain retained in the CDT of being able to approach the Dominions and Colonies seemed almost to demand a concerted Empire approach. An idea was even floated by Viscount Addison, the Secretary of State for the Dominions, that there might be set up 'some special machinery, such as a Commonwealth Liaison Committee, for keeping Dominion Governments in touch with the organisation and progress of our scientific work in this field'.[111] As with everything else, though, such a step must await the conclusion of a new agreement with the Americans. For now, the British must tread very carefully. It was still hoped that a balance could be struck between fealty to the strict secrecy associated with the tripartite nuclear alliance and the desire to maximise Commonwealth connections, though doing so would prove remarkably difficult in practice.

The test came in the spring of 1946, when the Dominion prime ministers convened in London for their first conference since the end of the war. A paper on 'Dominion Co-Operation in Atomic Energy' was prepared for Portal to deliver at a session of that meeting, and the light it sheds on British aspirations and thought-processes is such that it merits quotation at length:

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[109] Gowing, *Independence and Deterrence Vol. 1*, pp.146-7
[110] Bothwell, *Eldorado*, p.180
[111] Tory to Rowan, 11th January 1946, DO 35/1775 (TNA)

> As Dominion co-operation is one of the cardinal principles of British defence policy, it follows that we must hope to secure the closest possible co-operation from the Dominions in the development of atomic energy. Dominions will naturally wish to organise research and development on this subject irrespective of any prompting from the U.K. The greater the effort which individual Dominions can devote to atomic energy, the greater will be the benefit to the Commonwealth as a whole. The question remains, however, whether each Dominion and the U.K. should proceed with independent plans, or whether there should be a co-ordinated effort based upon the plan recently approved by H.M.G. in the U.K., and the present plan of H.M.G. in Canada.
>
> There can, in our opinion, be only one reply to such a question. The development of atomic energy requires intensive research in a number of scientific fields. If the U.K. and the Dominions are acting in pursuit of independent plans, there must inevitability be a great deal of duplicated work, and consequent loss of time; whereas if research is organised in accordance with a general plan, each partner devoting particular effort to a specific group of problems and pooling results, progress will be greatly accelerated.
>
> If this method of operation, which H.M.G. strongly support, commands general assent, we could propose at the earliest possible moment to institute the fullest interchange of information and the fullest sharing of facilities with the Dominions. For instance, we would welcome the attachment of Dominion scientists for duty in all parts of our organisation. We shall be glad to lend help for research work in the Dominions either in the form of scientists or in the form of the latest information on research plant and equipment. As development proceeds, we should be very ready to consider with the Dominions the proper distribution of production between the various countries of the Commonwealth, together with the proper distribution and co-ordination of their research programmes.[112]

All this reflects an expectation, on the one hand, of significant benefits arising organically from the pursuit of independent nuclear research and development activities on the part of individual Commonwealth states, weighed against the infinitely preferable scenario of a co-ordination of programmes, resting on the model of personnel exchanges which had been envisaged in November 1944. The timing of such overt acts of co-operation depended, however, on the unresolved question of the relationship with the United States. Access to the knowledge still retained by the Americans was seen as vital to the British programme, and by extension to any corresponding work in the Commonwealth. Without access to American-held information, any programme would be delayed 'by at least several years'. Negotiations were proceeding slowly, and it was vital not to give the Americans any excuse not to proceed: American anxieties about 'the circle being widened' meant that it seemed inadvisable even to brief the Dominion Prime Ministers in too much detail, let alone to plan joint activity prematurely.[113] (Similar concerns had already put paid to a final effort by the Australians to place one of their personnel at Chalk River by approaching the Canadians directly: the

[112] Draft, 'Dominion Co-Operation in Atomic Energy', undated, c.17th April 1946, AB 16/283 (TNA)
[113] Canada Acting High Commissioner to Addison; 2nd May 1946, PREM 8/367 (TNA)

Canadians proved no more keen to prejudice collaboration with the Americans than the British, and the question was finally dropped).[114] This left the British with little to offer the assembled prime ministers other than a plea for patience:

> We feel… that while full Dominion co-operation is essential for the defence of the Commonwealth, the timing of administrative arrangements must be related closely to the progress of negotiations with the U.S.A., because of the direct bearing of these negotiations on atomic energy development in the whole Empire.[115]

A cohesive inter-Dominion programme would not be forthcoming. The Dominions could take concerted action in only two respects: by participating in a whole-empire geological survey, and by consenting to second scientists to Harwell in the same manner as the British and New Zealanders had demonstrated at Chalk River. The case for the latter hardly needed to be stressed: 'First rate scientific ability is extremely scarce in the world and we are very anxious to secure the fullest possible pooling of Empire resources'.[116]

These considerations had all informed the line Portal proposed to adopt in addressing the Dominion Prime Ministers. His starting premise was that 'We naturally desire Dominion co-operation to the full', and preferably in co-ordination rather than through multiple independent paths. The ideal was 'a co-ordinated effort based upon the plan recently approved by H.M.G. in the U.K. and the present plan of H.M.G. in Canada'.[117] A set of preparatory notes for his speech went further still: 'We think it would be an excellent thing if Lord Portal could exert all his influence to secure such Dominion team for Harwell, so that the Establishment could become an Empire Establishment'.[118] Yet the meeting in the end proved rather a haphazard affair; the vagaries of the various prime ministers' schedules meant that not all could be present at the same time, so in the end two separate discussions were held: one with Chifley of Australia present, but not Mackenzie King, and a second with Mackenzie King (who after all could not be left out of a discussion on a topic in which his country held such an important stake) after Chifley had departed. –

The conversation at the Prime Ministers' meeting was not unidirectional: the views of the Dominion prime ministers were actively solicited. Mackenzie King noted that 'Canada would certainly be able to help by the provision of raw material and would gladly make whatever contribution they could through the seconding of scientists to work for a period in the United Kingdom', sentiments which Evatt, standing in for Chifley, echoed: '[Australia] would certainly be willing that their scientists should continue to co-operate in work carried out by the United Kingdom Government, as had been done during the war'.[119] On the basis of such bland assurances the meeting concluded. In terms of substantive commitments or joint plans, little had been achieved – which was very much the point. In the absence of a satisfactory arrangement with the United States the British could only aspire to future collaboration, and pursue

[114] Mackenzie to Chadwick 5th February 1946, and *cf.* Cockcroft to Chadwick, 22nd January 1946, RG77-D-1-b. Box 284 'Radiological Research. Policy Vol. 2' (LAC); CJM diary, 13th February 1946
[115] 'Draft, 'Dominion Co-Operation in Atomic Energy', undated, c.17th April 1946, AB 16/283 (TNA)
[116] Brook to PM, 20th May 1946, PREM 8/367 (TNA)
[117] Portal to Lindsell and Perrin, 11th April 1946, AB 16/283 (TNA)
[118] 'Notes on Harwell for Lord Portal's Speech', AB 16/283 (TNA)
[119] Prime ministers' meeting, 22nd May 1946, PREM 8/367 (TNA)

piecemeal initiatives in the meantime; the Dominions could only exercise patience and develop their own, independent plans in the hope of future consolidation.

New Zealand had planned its own programme, consisting of several distinct courses of action. First, the existing programme of uranium and thorium survey work would be continued. Second, a team of up to ten scientists would be established at the Dominion Physical Laboratory, working to a programme of 'Fundamental atomic research in co-operation with scientific organisations abroad'. This team, working, on the whole, without 'expensive apparatus', would also cover health issues, mineral testing, technical advice, and – most interesting – 'methods of enrichment'.[120] The third strand built upon the wartime secondments, envisaging the despatch of four personnel every two years to 'nuclear organisations in the United Kingdom and Canada' in order to 'ensure that New Zealand keeps up to date with new developments and techniques'. Salaries and expenses would be met by the New Zealand government; in return for this largesse, they expected a veritable shopping list of *quid pro quo* from their partners, including: 'Assurance of the return of the scientists sent abroad'; 'Supplies of artificially radioactive elements'; 'technical information'; and 'Co-operation and liaison work in connection with the laboratory in New Zealand'. A range of administrative steps were taken to allow for the administration of the country's new Atomic Energy Act, including the constitution of an advisory committee and the advance approval of spending up to £19,000 per annum. This all was approved by the New Zealand Cabinet on 25th January 1946.[121]

As of April, the idea was that Watson Munro, Fergusson, Page and Manssen would come to the UK, with George, Young, and Allan remaining in Canada for the time being, with some combination of these counting as the official complement of four New Zealand secondees, and the remainder being kept on the United Kingdom payroll. A separate New Zealand-Canadian arrangement would be required if any of the three personnel to remain in Canada were to be classed officially as New Zealand secondments.[122] Mackenzie was not averse to the idea of further New Zealand secondments, but noted that he would prefer to have 'experienced members… rather than inexperienced juniors who would be of little use to us'; Chalk River could not simply be used as a training venue for British and Dominion personnel.[123]

The Australians, too, had been active, persevering in their hunt for uranium and hoping soon to leverage the information obtained by their nationals overseas. As Evatt noted, Australia was 'vitally interested in the subject, not only on account of its military applications, but because of its vast industrial possibilities' – a point worth stressing in light of his country's lack of oil and limited coal reserves.[124] Evatt therefore wanted to know if Australia could get hold of the report of the Anderson Committee regarding the research establishment (plus 'sufficient technical information to form a true appreciation of the possibilities'). He told Attlee:

[120] Of course very little could be achieved by so small a team in the way of, for example, uranium enrichment; the commitment to explore these various field should be read more as a marker of intent.
[121] [NZ] Minister of Scientific and Industrial Research recommendations on Atomic Energy and Atomic Physics, 17th December 1945, AB 1/183 (TNA)
[122] Cockcroft to Marsden, 3rd April 1946, AB 1/183; Cockcroft to Sumner, 3rd April 1946, AB 1/183 (TNA)
[123] Mackenzie to Cockcroft, 12th April 1946, AB 1/183 (TNA)
[124] Evatt to Attlee, 14th October 1945, CAB 130/3, also in PREM 8/112 (TNA)

> My Government is determined that Australia shall keep abreast of the rest of the world in industrial developments. In the case of atomic energy we are starting at a disadvantage, since so far we have not been able to share in the information obtained because of the military considerations involved; there now seems to be no reason why we should be excluded[125]

He therefore wanted discussion to be instituted 'immediately' to permit 'full Australian participation' in nuclear work.

> It is unnecessary for me to stress the advantages of a Commonwealth effort in this supremely important field of research. In Australia we are anxious that this should be started; if it is not, however, we shall be forced to enter the field on our own. The contributions we could make to an Empire scheme are significant. Primary research and development might best be carried out in the United Kingdom, but we could send skilled scientists to assist in this purpose.[126]

He also noted, tantalisingly, that for later work Australia had 'large open spaces' and plentiful hydro-electric power, plus extensive thorium reserves, and reiterated their countervailing desire for 'as complete information as possible of technical details and future plans'.[127]

What the Australians seem to have desired most of all, however, was for Oliphant himself to return, however briefly, to Australia to brief them in person on the nuclear future. The British would have much preferred Australia to have sent someone to the United Kingdom, rather than sending Oliphant to them. The Australians were, however, fixated on Oliphant, who had, after all, been a reliable conduit for information for the past five years. A meeting in London to discuss the question would appear, from the account given, to have become rather tense: the Britons present were asked, 'somewhat pointedly', if there were any personal objections to Oliphant at work. The Minister simply glossed over the comment.[128] The record also makes clear that it was Oliphant in particular that the Australians wanted: they might equally have pressed for Massey, for example, but they do not appear to have made any such effort. The British had no real grounds for blocking the Australian request, however, and so ultimately relented. The suggestion was made that before he left, he should be given 'a tactful intimation concerning the need for discretion in the subjects he discusses', in order to ensure that there might be no 'disclosure of secret information'.[129]

Part of the objection to his going had been that Oliphant's stock had faded dramatically in British eyes. An instance of 'indiscreet talk' with a Member of Parliament had led to details of the Quebec agreement being made public,[130] and patience with his manner of engaging with colleagues and superiors was wearing a little thin. For the Australians, though, Oliphant remained a real asset, a valuable source of information and advice on an issue of immense consequence. The Australians may, in other words, have been rather

[125] Evatt to Attlee, 14th October 1945, CAB 130/3, also in PREM 8/112 (TNA)
[126] Ibid.
[127] Ibid.
[128] Note of Meeting at the Dominions Office, AB 16/223 (TNA)
[129] Lindsell to Rickett, 2nd March 1946, AB 16/223 (TNA)
[130] See discussion in CAB 104/285 (TNA)

counting on Oliphant's indiscretion. In the event, no trip to Australia took place in 1946. Oliphant did, however, serve as adviser to the Australian delegation at the UN talks on international control of the atom, and in so doing placed himself in the 'impossible position' of having to give them advice without breaching the strict requirement, of which he was explicitly reminded, that atomic energy should not be shared with other Commonwealth Governments.[131]

This phase in Anglo-Australian discussions coincided with confirmation that Australian uranium prospects were not, in fact, as promising as had been hoped, a voluminous but ultimately disappointing report on the wartime exploration work having now been filed.[132] There was hope that other sites in Australia might prove more promising, but exploration in the country progressed only very slowly. The lack of progress was unsurprising given the inadequate staffing of the state geological surveys, none of which had more than eleven geologists on the strength. In Western Australia and Queensland, the notional area of land covered by each geologist was greater than 100,000 square kilometres.[133] Frustratingly, little could be done to ameliorate the situation: a quirk of Australian federation reserved mining and associated matters to the state level, and repeated efforts to construct a national geological survey had failed – making Australia the only Dominion without one.[134]

Britain's other great hope for the procurement of uranium resources was South Africa. Smuts had been well-briefed on nuclear issues, and there had been a number of interactions around the uranium prospects in the country, but Union personnel had been absent from British wartime work, and South Africa had had no equivalent programme of its own.[135] They now sought to make up for lost time, establishing a Uranium Research Committee under Basil Schonland, a physicist, who as head of South Africa's newly-constituted CSIR was well-suited to the role. To his committee fell the tasks of co-ordinating South African research and, importantly, of liaison with Britain, the United States, and, 'where necessary', other Dominions on technical and scientific matters (issues of inter-governmental policy being reserved to the Department of External Affairs).[136] It was swiftly agreed that the channel of communication between this committee and the British Government should run directly between Portal and Schonland, and that such communication should encompass regular reports in both directions.[137]

On the question of resources, however, relations were less constructive. The geologists now seemed positive about the prospects of uranium mining in South Africa and though the work was still at a very preliminary stage a formal approach was made to Smuts via Attlee, seeking an agreement on the disposal of whatever uranium might eventually be produced.[138] The response, however, was disappointing. Smuts claimed to have been 'at pains to discover' whether British wishes could be met, but pleaded the 'serious difficulty' posed by what he described as 'the dearth of knowledge with regard particularly to the economic possibilities of uranium' as grounds for his government's reluctance to 'commit itself even in principle to

[131] Rickett to Anderson, undated, CAB 126/304; Draft of Anderson's letter to Oliphant (probably written by Rickett), CAB 126/304 (TNA)
[132] Peirson to Eaton, 28th February 1946, AB 16/70; Akers to Oliphant, 4th February 1946, AB 16/70; and elsewhere in file (TNA)
[133] Extract, Paper by E.S. Hills to Royal Society Empire Survey Conference, June 1946, AB 16/70 (TNA)
[134] Rivett to Peirson, 28th July 1946, AB 16/70 (TNA)
[135] See Chapter Five.
[136] Scallan (Acting HC in London) to Under-Sec. Dom. Aff., 11th April 1946, AB 16/739 (TNA)
[137] Peirson to Clutterbuck, 29th April 1946, AB 16/739 (TNA)
[138] Attlee to Smuts, 15th December 1945, AB 16/379 (TNA)

an obligation the implications of which none can foresee'. The British proposals, which had been rather modest and favourable to South African interests, were to be left 'in suspense'. There was thus little comfort in Smuts' caveat about ensuring control so that 'supplies of this new source of frightfulness and power will not find their way to hands that might abuse it'.[139]

The British were mystified by this unenthusiastic response. After all, 'to whom else but the United Kingdom would South Africa wish her supplies to be made available[?]'.[140] The obvious answer, which the British seem to have ignored, was the Americans. The South African historian Lucky Asuelime's suggestion that Smuts likely had not appreciated the United Kingdom's delegated function of approaching the Dominions on behalf of the CDT finds support in the archives, which show the British first envisaging briefing the South Africans on the CDT in January 1947,[141] and Asuelime is also right to note that the South Africans would anyway have been drawn to the prospect of access to American dollars.[142] The British, however, felt sure that Smuts and the South African government understood the 'plain fact' that

> it is vital in the interests not only of the United Kingdom but of the Commonwealth as a whole, including South Africa, that there should be the widest possible development of atomic energy in this country.[143]

The issue could therefore be construed as one of Commonwealth solidarity. This was a context in which the abiding tension between communicating freely with the Dominions and respecting American-imposed secrecy

> We are very conscious that we have not been able to take up these matters officially with Dominion Governments since [the] whole topic has had to be treated with extreme secrecy… We should hope that if picture were put fully before General Smuts we could look for a favourable response and that he would appreciate [the] vital need in the general Commonwealth interest for the United Kingdom to be assured of supplies of raw material, and to be put in the strongest possible bargaining position *vis-à-vis* the Americans, on whom we are still dependent for much in this matter[144]

It was consequently vital 'both in our own and the general Commonwealth interest, that there should be earliest possible production of atomic energy in this country'. Apart from large-scale expenditure, this required two essentials: raw materials, of which supplies were thought to be limited, and American co-operation, the latter being 'indispensable to early progress'. The expectation that American consumption of the major part of the material falling under CDT control (that is, all material outside the Empire and the United States) would continue, and that the CPC would be unlikely to condone a more equitable division, meant that to avoid a shortfall for the UK programme new sources must be discovered. Yet the exchange of scientific and technical information with the United States, 'of first importance on Imperial as well as

[139] Smuts to PM, 21st December 1945, AB 16/739 (TNA)
[140] Dominions Office to UK High Commissioner (South Africa), 30th January 1946, AB 16/562
[141] Asuelime, 'Uranium Politics of Gatekeeping', p.38
[142] Ibid.; JSM to MoD, 13th January 1947, AB 16/307 (TNA)
[143] Dominions Office to UK High Commissioner (South Africa), 30th January 1946, AB 16/562 (TNA)
[144] Ibid.

domestic grounds', had hitherto depended at least in part on Britain's ability to develop uranium sources for the CDT; if a new arrangement was to be implemented, it was clear that 'we on our part must be contributors as well as receivers'.

> In short, [the] position is that our ability to make a substantial contribution to the raw material pool may prove to be a decisive factor in our continuing to obtain essential requirements (both by way of information and otherwise) from the Americans whose full co-operation will be indispensable to us until our own research programme has developed further.[145]

The continuity of Britain's participation in the mechanisms of the CPC and CDT, which meant by extension the effective continuance of British nuclear development, and ultimately the prospects for other Dominions' nuclear development, depended substantially on the establishment of a durable arrangement with the United States.

> Once satisfactory arrangements have been concluded… and are firmly under way we hope to broaden their scope so as to ensure benefits of exchange of information to other Dominions as well as Canada, but our ability to do this will perforce depend upon whether we can negotiate a satisfactory agreement with the Americans in the first place, and this in turn… may be dependent on our ability to count on supplies from South Africa[146]

It followed that the United Kingdom's ability to dispose of the balance of South African output 'for some years ahead' was of 'crucial importance' both to Britain and the Commonwealth. The precise terms were less consequential; what was needed was South African assurances.[147]

The thread was picked up again with Schonland in June 1946. Data on South African ores was still remarkably patchy, given the levels of allied interest in the country's potential: Schonland confirmed that good data on the Witwatersrand ores really only stretched to a single mine, Blyvooruitzicht. It seemed reasonable, however, still to proceed with exploration. Portal asked 'whether further action… depended on this country', to which Schonland answered that 'Smuts had made up his mind that the scheme should be pursued, but Lord Portal's opinion would strengthen his determination.' The discussion then turned to the idea that South African scientists might be posted to the UK for research work; notionally for a stint of at least a year, with the scientists – physicists and engineers, preferably – to be recruited and paid by the South African Government. Schonland was understandably keen.[148]

British subordination to the terms of the CPC and CDT, and beyond that to American good will, can therefore be seen to have severely limited opportunities for the more obvious forms of joint endeavour with the Dominions, but there remained space at the margins for more imaginative solutions to be advanced. The most striking was a scheme advanced by the foreign secretary, Ernest Bevin. Bevin understood that concern over a UK-based development facility's strategic vulnerability was one of the Americans' chief

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[145] Dominions Office to UK High Commissioner (South Africa), 30th January 1946, AB 16/562 (TNA)
[146] Ibid.
[147] Ibid.
[148] 'Uranium reserves of South Africa', meeting 20th June 1946, AB 16/307 (TNA)

reasons – or 'excuses', as he put it – for withholding further collaboration, and he also knew that although the Chiefs of Staff were inclined to discount that risk, the Canadians seemed to be erring towards the Americans' perspective on the issue. He therefore ventured an alternative approach, which promised to solve the issue of Britain's proximity to Europe whilst avoiding excessive dependence on American goodwill:

> I wonder whether we should not consider erecting our pile elsewhere; if not in Canada, possibly in Africa, taking advantage of the water power at Victoria-Nyanza or even in Australia[149]

Bevin did not mention the idea in any of the meetings with Dominion Prime Ministers, but returned to the theme a week later, writing to the Prime Minister that

> I hold the view strongly that our main atomic energy development ought to be placed at the Victoria Falls. This location is protected, has the necessary water and electric power, and would ensure the necessary prodution [sic: production]. It should enable us to assure the safety of the Pacific and Indian Oceans[150]

Bevin left little doubt about his sincerity, telling Attlee 'I do hope you will hold out for this proposal. Smuts, I think, would agree with it'.[151] Smuts may well have agreed, not least because the prospects for South African engagement with a programme in Africa would have been excellent. Whatever its strategic merits, though, the scheme was too ambitious. Montreal had been remote enough, and although direction of a plant in Kenya would be more straightforward constitutionally and administratively than Canada the mere tyranny of distance would still play a confounding role. Assembling a workforce would be far harder, too. Politically and practically the centre of gravity was now in the United Kingdom, and must remain there whatever the risks. Bevin's final point, about assuring 'the safety of the Pacific and Indian Oceans' was, meanwhile, hopelessly confused. By any reckoning, security would emanate not from the placement of a nuclear facility in the empire, but from the deployment there of nuclear-capable forces, which even in these early years of the Cold War could be achieved. If anything, the reverse was true: dispersal of production facilities beyond the British Isles was a safeguard not to those regions, but to the United Kingdom. What the idea shows is a brief vignette of the thought processes at work; it highlights the alternatives which were considered and rejected. This, in turn, highlights that while the preservation of the empire was one impetus, of several, for the pursuit of a British bomb, the empire itself could not ultimately form the basis for the programme.

British policy throughout this period had been based upon the 'tacit assumption' that bombs were to be produced in the United Kingdom.[152] Such assumptions had served well in the design of Harwell, but the

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[149] Bevin to PM, 24th April 1946, AB 16/283 (TNA)
[150] Bevin to PM, 1st May 1946, PREM 8/367 (TNA)
[151] Ibid.
[152] Perrin, 'Notes for proposed talk with C.O.S. / Military Applications of Atomic Energy', 12th November 1946, and *cf.* handwritten note for CoS, 13th November 1946, AB 16/1905 (TNA): 'I do not suggest that there is the slightest doubt that the atomic bomb should be developed here.'

question of actual weapons-relevant work now loomed, and such actions required official sanction. Portal discussed future plans with both the Prime Minister and the Chiefs of Staff in November. The essential features of the programme were already determined: Harwell was the experimental and theoretical hub, and planning for production was in hand elsewhere. There was also hope that 'under the counter' support from the Americans might ultimately be forthcoming.[153] It was already clear who should lead the work: the British physicist William Penney was the only logical choice. Penney had served at Los Alamos, had developed a particular rapport with the Americans, had seen first-hand the devastation in Japan, had participated in the Americans' 'Crossroads' weapons tests, and had held comparably complex administrative roles within British defence science. At about the time Portal broached the topic with Attlee, Penney had written (and for secrecy's sake typed himself) a report on the organisation of a British atomic weapons programme.[154] He too had suggested that immediate steps could be taken towards a full weapons programme. This was undoubtedly true: there was plenty of development work that could be done even without fissile material to hand.[155] Indeed it would be unwise, if speed were of the essence, to delay on the preparatory work: the two programmes could work in parallel. It would be best, though, to proceed under the camouflage of existing institutions: 'new wine into old bottles', as it were.[156]

On the last day of 1946, Portal formally submitted to the Prime Minister 'a decision is required about the development of Atomic weapons in this country'.[157] Three possible courses of action were suggested, but the implication that there was a decision to be made is perhaps somewhat illusory: the Chiefs of Staff, and in all likelihood Attlee himself, had already endorsed a secret programme under Penney. Still, the legal forms must be observed. Rather than consider the issue in full Cabinet, Attlee convened a special cabinet subcommittee, a 'highly atypical, and arguably unconstitutional' step.[158] Their decision on 8th January 1947 was therefore no major policy departure, but rather an acknowledgement of a programme already tacitly agreed.

Having begun with the impact of one supposed watershed – the destruction of Hiroshima – this chapter thus closes at another. The Attlee government's decision to pursue a nuclear weapon may not have been all that much of a policy departure, but it still serves as a convenient historiographical book-end, for it marks the moment at which the Prime Ministerial imprimatur was finally placed upon a policy to which each administrative iteration of UK nuclear research and development from 1940 onward had been orientated: that Britain was committed to the development of an independent nuclear weapon. Of course much remained unsettled. Policy-makers clung doggedly to the hope – faint, but enduring – of a return to wartime patterns of collaboration with the United States. For as long as such a hope remained, the prospects of actual Commonwealth collaboration on nuclear development remained diminished. There was still a space for Dominion participation in the work, but that participation could only complement, rather than underpin, British plans. For the increasingly assertive Dominions, that was likely to prove hopelessly inadequate.

[153] Handwritten notes for CoS, 13th November 1946; 'Meeting with PM', 19th November 1946, AB 16/1905 (TNA)
[154] 'Proposals for an Atomic Weapons Section in the Armaments Research Department', Penney, AB 16/1905 (TNA)
[155] Handwritten note for meeting with PM, 19th November 1946, AB 16/1905 (TNA)
[156] Arnold, *A Very Special Relationship*, p.10
[157] 'Note by the Controller of Production of Atomic Energy', 31st Dec 1946 CAB 130/16 (TNA)
[158] John Bew, *Citizen Clem: A Biography of Attlee* (London: riverrun, 2016), p.420

Conclusion: Britain's Nuclear Future

The end of the war was also, perforce, the end of the period of governmental silence on nuclear issues. The hellishly public advent of the atom bomb meant that influence over nuclear policy passed from the hands of a small cadre of scientists advising a yet smaller cadre of officials into the wider arms of government in all its multifarious, bureaucratic complexity. Entire programmes of work were placed on new footings, and although much remained secret the ranks of those inducted into the deliberations on technical, diplomatic and military policy grew almost exponentially. This was the case for each of the nuclear partners, but also for states – Commonwealth or allied – whose exposure to nuclear knowledge during the war had been limited (*e.g.* France) or non-existent (most of the rest of the United Nations). The scramble to articulate nuclear policy, and to capitalise, where possible, on relevant assets was almost universal. For the United Kingdom, though, there were two other significant and particular consequences of peace.

First, peace brought confirmation of American dominance as the presiding influence in British decision-making. The relationship with America was at once indispensable and galling. It could not be reversed and would long stand as a constraint to be chafed against. The increasingly forlorn hope of salvaging further gains, in terms of material, information and exchange, from the wreckage of the post-war settlement, compounded in the iniquitous McMahon Act, shaped British nuclear policy for the best part of a decade. Britain never wholly forsook the Commonwealth as a nuclear partner however. Bevin's idea of a commonwealth nuclear facility in Africa, fanciful though it almost immediately proved, underscores the extent to which the leveraging of empire – Dominions and colonies alike – remained an aspiration of British policy, even as circumstances consistently conspired to prevent their realisation. The hindsight of multiple generations sees Bevin's concept of an imperial nuclear hub in sub-Saharan Africa as little more than a flight of late-imperial fantasy, but viewed in context it made a degree of sense. There was nothing inherently illogical in Bevin's embracing the Mackinderian idea of leveraging empire as a counterweight to the grand continental powers, nor was it incompatible with Labour's distinctive imperial policy, which Bevin and Attlee had chiefly designed.

Second, peace necessitated a radically different relationship with Canada, conditioned by the unique wartime conditions that had shaped their nuclear relationship operating in conjunction with the wider constitutional and psychological evolution of Canada into a middle power. The idea of Chalk River as a united Commonwealth endeavour was consequently still-born: it was evident to all concerned that the Americans would never countenance such an enterprise. The more limited aim of a joint Anglo-Canadian programme similarly foundered, though the extraordinarily close collaboration between Chalk River and Harwell significantly mitigated the technical separation of their programmes.

Britain began the war suspended awkwardly between a status of notional suzerainty and a position of primus inter pares. By the end of the conflict, and only vestiges even of the idea of primus inter pares remained. This is not to say that the Dominions repudiated the Commonwealth entire: there was still much in it of value. It had, however, undergone a significant evolution.

Conclusion:
The Dominions and the Bomb

Historians, as John Lewis Gaddis has pointed out, swim in the medium of complexity.[1] In historical explanation a phenomenon cannot be reduced, as in the social sciences, to causation by a single independent variable, but rather emerges from the complex intersections of multiple factors, their antecedent causes multiplying back exponentially into the past. This blessing and curse of complexity is compounded, in the case of nuclear history, by the lingering shroud of state secrecy – a phenomenon encountered even in the preparation of this thesis – and the pall of tragedy which still lies, after seven decades, over this most destructive of human technologies. Yet for the historian this complexity is not so much daunting as intriguing. Viewed rightly, the appearance of opacity and intractability is an opportunity for explication.[2] This mentality informed the present work.

This thesis originated in the observation of a lacuna in existing accounts of the early British nuclear weapons programme. A great many of the prominent scientists and engineers who participated, often very prominently, in British nuclear research were not themselves unambiguously British, and yet the phenomenon of their participation had scarcely been acknowledged by historians, still less considered in the depth it deserved. This thesis therefore sought to fill the gap, by examining directly the nature and extent of Dominion participation in British wartime nuclear work. British nuclear interactions with the Dominions, which prove to have been surprisingly extensive, have been downplayed or ignored in the literature primarily, it seems, because they did not subsequently bear much fruit. This, however, is unfortunate. The practice of history is not simply the narration of what happened (*wie es eigentlich gewesen*), but the consideration of precisely *why* it happened – and this requires, in turn, a consideration of what the protagonists *hoped* might happen, what they *expected* might happen, and what they actually sought to *make* happen. Commonwealth dynamics figured in each of these processes.

The working hypothesis here was that the Commonwealth, as an underlying concept, as a set of pre-existing relationships, and as a contested ideology, formed key dynamics influencing the development of the programme. Only an appreciation of these Commonwealth dynamics within the United Kingdom nuclear programme can account for such phenomena as Mark Oliphant's foundational role in three nations' nuclear histories, or the fact that New Zealanders helped build the first plants at Chalk River and Harwell; only a holistic view of Commonwealth interactions can fully explain the course of British nuclear policy in this period.

Much of the focus of this thesis has been on granular analysis of individual processes and decisions – unashamedly so, for it is here that Commonwealth dynamics are most directly evident, and here too that misapprehensions can arise. To engage with nuclear history only at the level of high diplomacy is to

[1] John Lewis Gaddis, *The Landscape of History: How Historians Map the Past* (Oxford: Oxford University Press, 2004), p.65
[2] *cf.* Robert Darnton, *The Great Cat Massacre and Other Episodes in French Cultural History* (New York: Basic Books, 1984), pp.4-5

overlook much of what actually determined the course of nuclear history. Much, of course, depended on the interactions of Prime Ministers and Presidents, but much also depended on the individual interactions of scientists, engineers and administrators, whose technical work, correspondence and personal reflections are preserved in shelf upon shelf of archival material, both in the capacious National Archives and in its counterparts around the world. These archival materials corroborate one another: the picture that emerges from one national archive tends to be mirrored in another. Direct references to the Commonwealth were proportionally rare: the concept of Dominion relations was not the lens through which the protagonists of this history consciously viewed their decision-making, and few files were created or catalogued on the basis of imperial concepts. In history, though, the phenomena of greatest relevance are not always those which the archives name, but rather those which, by being taken for granted, go un-named.

Here, in this concluding chapter, it would be well first to recapitulate the narrative of the preceding pages; then to identify the key themes at work; and lastly to present the sum of this thesis' argument and its implications for diverse fields.

Recapitulation

Nuclear weapons have a long pre-history. Building on developments in human understanding of the structure of the atom in the early decades of the 20th century, the discipline of nuclear physics advanced apace in the inter-war years. Advanced scientific enquiry within the British Empire was concentrated within the metropole, but drew in personnel from all its disparate territories through mechanisms such as the 1851 scholarships, and redistributed many of these men (they were almost exclusively men) back to the imperial periphery, there to pursue work of (ordinarily) a more prosaic or industrial bent. This concentration and dispersion of personnel thus led to the organic formation of inter-Dominion scientific relationships, of which the informal network that grew up around Rutherford – himself a New Zealander – is the most conspicuous example. This network, nestled within the close-knit confraternity of pre-war nuclear physics, provides the context for many of the internal and cross-border interactions that shaped nuclear policy-making in its early stages, when the prospect of harnessing atomic energy release (explosive or not) became too alluring and terrifying to be ignored. A flurry of experimental results published in 1939 had left the field in a state of flux, but in spite of uncertainties as to the precise mechanism of nuclear fission there were certainly strong grounds for state-backed investigation of the newly discovered phenomenon of uranium fission. British science was well-placed for this endeavour.

The thesis' narrative opened at this parlous moment. The first chapter discussed the origins of the United Kingdom's wartime nuclear research programme, highlighting the fact that initial conditions favoured the inclusion of individuals with their origins in the Dominions but who by providence or design were at that point domiciled in the United Kingdom, with Mark Oliphant their exemplar. It was in this early period, too, that the first contacts with Canada were made, and the idea of crossing the Atlantic first arose. The impetus for the UK programme came from two emigres, Frisch and Peierls, though they were not the first to have considered the question, and their memorandum was not wholly unanticipated. Chadwick had been at work longer, and was nearing a similar conclusion, but was far too rigorous a Rutherfordian to circulate a theory, even a rigorously coherent one, without strong experimental support. Frisch and Peierls did, however, have

Oliphant as their highly credible champion, and the advantage of a clear and compelling set of well-supported hypotheses; consequently it was their insights which propelled the MAUD committee into existence. Judged by its own limited aims, MAUD was an efficient committee, not especially urgent in its undertakings, despite the overshadowing threat of invasion and the alarm occasioned by the misinterpretation of the MAUD RAY KENT message, but thorough and effective in its investigation. Crucially, the Committee sought a fuller understanding of – and to establish links with – the work of other nuclear physicists around the world. This desire, coupled with the need to identify and if necessary accumulate resources for a future programme, drove contacts with the United States *and Canada*. Canada, indeed, became a key subject of MAUD discussions, as a source of uranium, as a potential location for Halban's heavy water work (initially conceived as a lower-priority, long-term endeavour, divorced from weapons applications), and, importantly, as a locus for nuclear research in its own right. Laurence's independently initiated work in Canada was hardly a coherent programme (certainly not in comparison with even the early work in the United States) but the British were nevertheless very interested to learn of its extent, to study its conclusions and to ensure its continuance.

The second chapter reflected on the implementation of the MAUD report and the processes by which the centre of gravity of nuclear research shifted from one side of the Atlantic to the other, as the American work gained momentum and the British work stalled. MAUD recommended two parallel endeavours: a fast neutron programme (directed towards the bomb) and a slow neutron programme (directed towards power production). Both were important, but the two were conceptually disaggregated, with the fast neutron work accorded by far the greater priority. The desire to secure American partnership in fast neutron research and the need to find a host for Halban's then low-priority slow neutron work led the British to look across the Atlantic, to Canada as well as to the United States. Ongoing research meanwhile began to indicate more clearly that the slow neutron programme might in fact have weapons-relevance, via the newly identified plutonium pathway. Recognition of this changed the complexion of the Halban conundrum. This also was rather a fallow period for the British programme, a time of organisational change and personnel churn, and so they lost momentum relative to the American programme, which the British half-inadvertently catalysed via several influences (including the probably unsanctioned intervention of Mark Oliphant). Oliphant's exploitation of his personal network to advocate strongly for MAUD's conclusions is evidence of his personal hawkishness on the bomb, but also says something interesting about the way the British and American programmes became intertwined: rather than having been high level and programmatic, contacts began at the personal level. This helps explain, alongside the question of timing, the very awkward interactions between the two programmes: their priorities never quite coincided, and whenever one state was willing to endorse closer ties, the other would shy away. It was not simply that the British rejected the Americans, though some accounts may give that impression. The first overture on collaboration came from the British, and though they were admittedly guilty (if that is an appropriate expression) of rejecting subsequent approaches, their reticence made sense given past experience and the United States' non-belligerence prior to Pearl Harbor. The sudden invigoration of the American programme was such that the British could not respond quickly enough: they were forever reacting to the *previous* American position. By 1942 the British were thus ready to embrace the Canadian option, albeit with the clear motive of leveraging that work *vis-à-vis* the negotiations with the Americans for fast neutron work. There were, however, intimations of trouble to come: the relationship with the United States, which had already become

central to British policy-making, underwent a transition precipitated by the United States' entry into the war and the corresponding transfer of the American programme to civilian control. Then the question of Halban became compelling once more, but again it is important not to try to disaggregate the slow neutron question from the fast: by early 1942 the British were trying desperately to bring the Americans onside in both fields, with a far stronger emphasis on the fast neutron work, which still seemed by far the most promising field of research. The offer of slow neutron collaboration was an additional inducement, a potential form of leverage. The British attempted to use the asset first by offering to place Halban and his colleagues in the United States. This ought notionally to have been a win-win situation, but there were impediments on the American side – structural issues around secrecy, for example, even before the army takeover and the legacy of complicated relations made it difficult. Yet both sides remained amenable to the development of some kind of collaboration, and at length they triangulated on a mutually acceptable solution: they could locate the slow neutron programme in Canada. This was a reflexive step, perhaps, but one built upon earlier contacts and pursued in full conversation with the NRC: it was no act of imperial imposition. (Indeed, the terms on which the Montreal programme was ultimately based proved less than optimal for British interests in the longer term: a significant degree of control was ceded to the NRC.) Each of the three parties concerned derived a benefit. The Americans gained proximity to a team pursuing complementary work, without the headaches of hosting them; the British likewise gained proximity to the American work, and the chance thereby to demonstrate the utility of closer ties; and the Canadians gained trusteeship over a major joint endeavour, and through it exposure to a vast amount of information and experience.

The third chapter addressed the awkward adolescence of the project in Canada, as British hopes of equal partnership with the American programme were repeatedly disappointed. The US emphasis had become more and more on secrecy – they were more confident than ever that they could develop a full programme alone. Whilst it was not necessarily Groves' fault that co-operation faltered, there is a sense in which the new regime did play a part, if only in enabling the instincts of Conant and Bush to raise barriers to co-operation. The Conant letter and memorandum sealed the adoption by the Americans of a directly combative strategy towards the UK, severely restricting interchange to a point where, if applied, information could flow in only one direction. This was the exact opposite of what the UK had hoped for. Britain therefore launched a concerted diplomatic effort to change things. Two schools of thought emerged, one advocating acceptance, the other advocating the adoption of a reciprocally hard line. The latter approach assumed Canadian acquiescence, but the Canadians (and British and émigré personnel associated with the Canadian project) were, for both technical and political reasons, far more inclined to the opposite view, believing, with good reason, that Britain could ill afford a protracted, aggressive negotiation with the Americans, and considering it better instead to salvage what collaboration they could, and by demonstrating good faith seek to claw back access and influence. Comprehension of this 'Canadian' perspective swayed the British from their impulse to adopt a hard line – albeit only after several months of a composite policy which had the effect only of straining relations at Montreal. The British eventually managed, through a combination of perseverance and forced affability to untangle and undermine at least some of the Americans' objections, leaving them relatively little room to manoeuvre by making generous concession on key points, arriving ultimately at their goal of joint-decision-making across every aspect of the project.

The fourth chapter covered the period in Canada after the Quebec Agreement in which, following a final diplomatic effort, the future of the Anglo-Canadian project at last seemed assured. Yet the narrative of the fourth chapter reads almost like the third, for the British found themselves again trying to persuade the Americans to grant collaboration, again debating amongst themselves the benefits of going it alone, and again being deterred by Canadian conditions and perspectives. The Quebec Agreement institutionalised the process of negotiation – but it was still a negotiation, and the British position was one of relative structural weakness. Conceived as a bloc, the Anglo-Canadian project had representational parity with the Americans, with three representatives each, but as the Canadians had already demonstrated, their sympathies lay as frequently with the American perspective as with the British. The notional three-to-three ratio of the CPC in fact reduced to an unfavourable three-to-two ratio for the British: they could never pursue too confrontational a line for fear that the Canadians might array their vote alongside the Americans, thereby shattering the precarious illusion of a united Anglo-Canadian (*i.e.* Commonwealth) position. The Montreal work, having saved the British fast-neutron connection with the United States in an elaborate and unlooked-for way, now found itself at risk, for it was becoming ever-clearer that it amounted to a post-war project.

The question was hashed out in a subcommittee of the CPC and – somewhat remarkably – the British were able to secure American support for a pilot plant. This was less than had been hoped, but more than was really realistic. American acquiescence is best explained as part insurance policy, part effort to bind the British in: they were, after all, already too tightly enmeshed into American secrets. Securing the future relevance of Montreal required significant changes. Frictions between Halban and Mackenzie had reached an intolerable level, and something must give: the politics aligned against Halban, who amongst other impediments had his non-Commonwealth origins against him. His replacement was Cockcroft, unoffensively English and blessed with an eminent scientific reputation. Cockcroft's appointment was not, of itself, sufficient to secure American support for Montreal, though. There followed a repeat of the pre-Quebec debate as to whether the United Kingdom might pursue its own wholly independent programme: a last hurrah for the advocates of an independent line. The combined risk of forfeiting American goodwill on the bomb project and of losing Canadian support meant that such an idea was finally rejected. The British were thus bound into the collaboration with the US and Canada at least in part by the dynamics of the triangular relationship. The British had turned to Canada as a reliable partner, for Canada's merits shone brightest when compared with the United States. Yet Canada's trajectory was much more towards the United States than towards the United Kingdom, and so the counterbalance which the British had sought to set up became the mechanism that bound them more closely to the US.

The ultimate practice of the triangular relationship was, however, fairly straightforwardly hierarchical for what remained of the war years: the United States and Britain made the running, and the Canadians were content with their more parochial concern for the maintenance of the heavy water project. Canada was represented on the CDT, but primarily as a courtesy; they made few significant interventions in the deliberations of the CPC, and the three-two-one representation pretty well approximates the ranking of the parties' importance.

The fifth chapter traced the late-war nuclear interactions of the other Dominions with the British programme. Ties with Australia were mediated, unofficially but fairly systematically, and from an early

stage, by Mark Oliphant, whose lax attitude to security may have been a factor in his having communicated significant information to the Australian government. Both Australia and New Zealand sought to contribute to the Anglo-American programme, hoping thereby to derive future benefits for their own states. The two countries fared rather differently in these endeavours, though, for whilst the Australian government sought to leverage all her assets into a broad-based agreement on co-operation (in essence, to be admitted to the nuclear club wholesale) the New Zealanders were content to provide support as and when the British required it, with few expectations attached. Thus the New Zealanders, despite having far fewer assets to leverage, achieved a proportionally far greater return: they placed seven well-qualified men within the British contingents in Canada and the United States, gaining first-hand experience of crucial fields of operation. Moreover, these men were secondees: they still 'belonged', as it were, to their home government. The Australians, in contrast, were able to attach just one man, Burhop, to the electromagnetic work, and not on the same advantageous secondment terms as the New Zealanders. Factors relevant to these two divergent trajectories include the differing personalities of the principals, and perhaps also differences in national outlook (New Zealand being far more associated with the ideal of imperial solidarity, for example), but it may be truest simply to say that Marsden and the New Zealanders better understood the paradox that humbler, more straightforward support of discrete projects actually secured greater national benefits, whilst adopting too transactional an attitude attracted far less preferential treatment. New Zealand, having pursued a more 'Commonwealth' conception of alliance than the Australians, accrued the lion's share of the benefits. The rest of the Dominions meanwhile tended to miss out – though it is worth noting that the South African Prime Minister, Smuts, was brought into Churchill's counsels on crucial questions of nuclear diplomacy – and the colonies were only ever treated as utterly pliable.

The sixth and final chapter was concerned with post-war planning. The prospect of the end of the war presaged a radical change in each state's decision-making calculus, the challenges associated with which were exacerbated by changes in government on both sides of the Atlantic. The British had laid plans, of a sort, for what would follow the war: Oliphant was a key mover in this. The main thrust of the British programme was to be the establishment of a large-scale facility within the British Isles (much though the Canadians might have hoped that their own centre at Chalk River, only just hitting its stride, might fill the role for the Commonwealth, and much though the Americans might fear the idea of a nuclear centre in what to them appeared a still acutely vulnerable location). The British were not to be deterred, however. The principle that had motivated the British from the outset, of having a programme of their own, proved dominant, and the impulse to plough a doggedly independent furrow, which had twice reared its head when things had become difficult with the Americans, finally had its victory – though there was no intention on the British side to sever ties with the Americans in consequence. This, however, was the likely consequence of such an action, and would have been a risk even without such a development, for the trajectory of post-war American nuclear policy was always towards full independence. One factor in this was the transfer to a broader basis of governance – from a small clique with limited oversight to the full might of political control. This happened everywhere, of course – it was a significant transition in Canada, particularly, where diplomats like Hume Wrong had very quickly to get up to speed in a dizzyingly complex new arena of international diplomacy – but was most pronounced in the United States, where an atmosphere of triumphalism had followed victory. American predominance in the manufacture of the bomb became, in the popular mind, American exclusivity in its manufacture; and although the British and Canadians were

given their due in the official communications, the details of the Quebec Agreement remained secret, and the Hyde Park memorandum doubly so – being unknown even to many of the American administration. This indeed was one of the key issues with the transition to post-war arrangements for the bomb: that too much emphasis had been placed on personal accommodation between Roosevelt and Churchill. Quebec's construction left too much to the assumption of American goodwill, and to the existence of a 'special relationship' which then as now was little more than a phantasm, a rhetorical flourish covering a multitude of colder calculations. Roosevelt' tendency was always to allow himself room to manoeuvre; quite possibly he never intended to preserve the close atomic relationship which he seemed to have promised Churchill.

It did not matter either way, for Roosevelt died, and his successor, though harbouring no ill will towards the British, was hardly inclined to extend them any favours, particularly as regarded the weapon which seemed, for the briefest of windows, to present his administration with the ultimate diplomatic trump card. And so the British were left once more to recalculate. The same essential plan was pursued – a research centre in the United Kingdom – but with a clearer emphasis on independent capability, and perhaps a degree of stoicism in the intention to get there with or without American help. The hope of a return to joint operation was never abandoned, however: the story of much of the early cold war was, for Britain, the story of the search for a nuclear accommodation with America.

It was this, more than anything, that restrained Britain's other impulse, to leverage the Commonwealth as a source of power. The British were unwilling to sever the American link completely, and so had to leave unfulfilled various half-ventured projects to create a coherent Commonwealth basis for their nuclear work. The distance that had emerged between the British and Canadian programmes perhaps contributed to this also. The Canadians were deeply wounded by what they saw as the British abandonment of Chalk River: the loss of Cockcroft felt, to them, like the withdrawal of British co-operation, for he more than anybody had symbolised both the importance of the work and its character as a unified endeavour. Thus, intriguingly, the Canadians seemed briefly to embrace the idea of Chalk River as a potential hub for Commonwealth nuclear research and development work. Yet that was not the whole of it, for there was also a strain of nationalism involved: they were almost adamant that they wanted a Canadian to replace Cockcroft, and it was only grudgingly that they accepted another Briton. It was not just the loss of the individual: the Canadians had felt that they held something of a trump card in their relationship with the British, being the location of the only plant, and they were disappointed to realise that it was not so strong a hand as they had hoped.

Ultimately, it was the American ascendancy that put paid to the tripartite alliance. The three states went their separate ways: the Americans into a frantic arms race with the Soviets, the British into a dogged and in some ways remarkably patient effort to catch up with their great ally, never wholly abandoning the hope of a return to tripartite action, and the Canadians to a future of nuclear power production rather than weapons development – the latter rooted more in the security guarantees that flowed from alliance with the United States, Commonwealth bonds with Britain, and ultimately from close alliance with both through NATO membership, than from an actual relinquishment of nuclear intentions.

Recurring Themes

Even from this crude precis, and quite apart from the recurring motif of divergent Anglo-American relations prompting the British to conceive of a radical independent course only to be reined in by explicit or implicit Canadian influences, a number of underlying themes are evident. These merit brief commentaries before the final argument of the thesis is presented.

The Significance of Individuals

Whilst it would be wrong simply to emphasise individual figures at the expense of wider historical trends, it would be equally wrong to deny the agency of individuals, for, as the narrative highlights, certain names are almost ubiquitous in British nuclear history. Oliphant, Groves, Cockcroft: for good or ill, the words and actions of these men carried particular weight, shaping their nations' nuclear programmes for decades to come. Less prominent in the literature, but of great significance here, are the Dominion scientific administrators Mackenzie, Marsden and Rivett. They too, in their achievements and failures, shaped their nations' nuclear destinies.

Consider Mark Oliphant. Quite apart from his own scientific research, Oliphant's impact on nuclear history was vast: witness his early patronage of Frisch and Peierls; his championing of the MAUD report in the United States; his wartime transmittal of information to the Australian government; his leadership of the British team at Berkeley; his role in shaping Manhattan's electromagnetic programme; and his enthusiastic participation in the establishment of Harwell. It is curious, then, that historians' summations of his legacy should be so conditioned by his later positions (and recantations). Oliphant also disseminated rather more information than perhaps he ought to have done: thanks to his efforts between 1942 and the end of the war, the Australian government (or at least elements thereof) were better informed on nuclear issues than almost any other state. Only those countries privy to the Quebec Agreement possessed more precise information, and at a conceptual/programmatic level (as opposed to an experiential/technical level) Australian information compared favourably even with the other states whose personnel had had access to the programme (that is, New Zealand and de Gaulle's Free French through legitimate means, and the Soviet Union through espionage).

Next, consider Leslie Groves, who merits the historical cliché of the 'towering figure', but also highlights the extent to which such figures can be misrepresented. In Groves' case the caricature has often prevailed over the actual character of the man. In particular, Groves' Anglophobia has been over-stated, skewed by his own post-war efforts to dictate the history of the Manhattan Project. He was not instinctively warm to the British, and seldom made concessions without a substantial *quid pro quo*, but he was consistent in his attitudes and for the most part wholly frank in his (wartime) communications: he was unmoved by emotive appeals or the concept of fair play for its own sake, but he could be swayed by a persuasive argument and delivered upon his pledges. His relationship with Chadwick was genuinely effective. His later summations of the impact of the British programme read harshly, but has been divorced somewhat from its context:

although a jealous guardian of his government's nuclear dominance, he was ultimately glad to have such an array of first-class minds at his disposal, and readily acknowledged the value of British contributions.

Then there is John Cockcroft, who for a time served as the emblem and goal of Anglo-Canadian co-operation; his withdrawal from Chalk River and appointment to Harwell came to represent something of a parting of the ways between the British and Canadian programmes. He holds the apparently unique achievement of having overseen the creation of two states' nuclear research establishments, and his leadership set the tone for nuclear research in Britain and Canada for decades to come.

Lastly, consider the four Dominion scientific administrators: Mackenzie for Canada, Marsden for New Zealand, Rivett for Australia, and Schonland for South Africa. Providence dealt each a different hand, and each adopted a different approach to the handling of his country's nuclear relationship with Britain. Marsden's deft and enthusiastic handling of his country's nuclear relationship with the United Kingdom bore tangible fruit; Rivett's assertiveness proved almost fruitless. Mackenzie's relationship with his British counterparts swung from close and collaborative to decidedly fractious, and back again; at times it served as a barometer for the state of Anglo-Canadian relations, and at times as an influence on them. Schonland, meanwhile, had to forge a nuclear relationship with Britain from scratch in a radically different post-war world. Yet amidst all these different experiences, one might also detect some commonalities. Each of the four sought to leverage, in one way or another, the Commonwealth connection, and all seem to have been genuinely committed to the idea of Dominion collaboration as logical and desirable. Where they differed was in their understanding of the nature of the connection and the form of the collaboration that could be pursued – a reflection, ultimately, of the polysemous character of Dominion status and the liminal position of the British Empire in the mid-twentieth century.

One might equally reflect on other individuals: Akers, whose private-sector career prior to Tube Alloys simultaneously equipped him for, and debarred him from, a leading role in the Anglo-American collaboration; Halban, whose research formed the basis for the entire Anglo-Canadian project, but who ended the war wholly detached from the allied programme; or Chadwick himself, whose unassuming negotiating style helped win Groves over.

Contingency

It is clear that the precise events related in this thesis were not inevitable: the labyrinthine nature of the negotiations, and the occasional dramatic policy reversals, attest to the contingency underpinning all that transpired. In some instances, very minor developments had significant consequences, and reflecting on the marginality of these cases raises some interesting questions. If Chadwick's health had been better, he would have been able to travel to the United States at an earlier stage in the negotiations with the Americans; might he have achieved better results than Akers? If Marsden had not learnt, through chance and his own acuity, of the existence of an Anglo-American nuclear endeavour, the New Zealand contingent might never have been sent to North America; might this have bolstered Rivett's case for Australian access to the programme? Or might the British have kept a greater distance from the Dominions altogether? If Zinn had accepted the directorship of Chalk River, which for a time he seemed inclined to do, might there have been

a cleaner break in the post-war Anglo-Canadian nuclear relationship? Or might Zinn's American contacts actually have helped maintain tripartite collaboration around the Canadian heavy water work? So it goes. To pursue counterfactuals is seldom helpful, but the knowledge that even slightly different circumstances might have altered the progression of events in potentially radical ways is a helpful corrective in the face of the historian's natural impulse to attribute the course of all history to grand impersonal trends (or, in the more archaic Carlylean fashion, to the visionary actions of great men).

Multiple tiers of interaction

The archival record makes clear the extent to which crucial interactions took place through direct institutional contacts and commonplace diplomatic channels. Indeed, it is striking how little time national leaders actually devoted to the issue. Much lay with Akers, Chadwick, and Mackenzie, under the often *laissez-faire* supervision Anderson and Howe; relatively little ascended to Churchill and almost nothing to Mackenzie King. The substantive discussions lay, for the most part, with the senior scientists and their administrative colleagues, under the oversight of a trusted cabinet minister. Issues rose from lower to higher levels, rather than percolating down. Escalation – particularly to Prime Ministerial/Presidential level – was as often a tool for obfuscation and delay as for resolution of a problem. The British, from Churchill down, often fell victim to Roosevelt's habit of 'genial deception'.[3] Conant and Bush were able lieutenants to Roosevelt in this respect. John Holmes' point about the occasional need for high-level reinvigoration of moribund negotiations stands,[4] but with the caveat that such instances were rare, contingent, and sometimes counter-productive. It would be wrong to assume that the history of Anglo-American nuclear relations is nothing more than the history of Prime Ministers' conversations with Presidents. The tone for inter-state nuclear interactions was set at lower levels, in individual encounters, institutional frictions, and the interface of bureaucracies, and thus ultimately influenced by cultural affinities and expectations.

Secrecy and Security

Secrecy was and is the inevitable concomitant of any matter touching on nuclear weapons. In the period before Hiroshima the very concept of the bomb, its plausibility and essential mechanism, were secrets of immense importance, kept with incredible zeal. This culture of secrecy never sat easily with most of the scientists involved, though few disputed its wartime necessity. Structures of recruitment and security clearance were also interwoven to an extent incompatible with a strict interpretation of national sovereignty, with direct consequences for the transmission of nuclear knowledge across borders. Crucially, since each of the nuclear partners conceived of secrecy and security slightly differently, the net effect was to foster division between allies.

[3] Bernstein, 'Roosevelt, Truman, and the Atomic Bomb', p.29
[4] Holmes, *The Shaping of Peace,* p.198

Alliance

If the allies differed on issues around secrecy, they can equally be said to have differed on the very meaning of their alliance. Given how the two sides approached the question of nuclear collaboration, one might argue that the British set greater store by the idea of alliance than the Americans, or perhaps more simply that they placed a greater emphasis on the spirit of an agreement rather than the letter. Did the British side contain fewer realists and more idealists? The shrewder of the British observers realised the futility of appeals to fair play and the spirit of wartime collaboration: 'Nothing makes less impact upon the American mind', noted one message, 'than British personnel harping upon past actions and moral rights'.[5] The British attitude was rather different when it came to the Canadians and the other Dominions, though, for here there was far more of an expectation of common ground. One might possibly go so far as to suggest that the recent experience of (relatively) easy inter-Dominion co-operation misled the British as to the likelihood of similar ease with their Anglophone allies. Then, as now, alliances were hard work. The very concept of the special relationship – so prevalent in contemporary discourse – has its roots in these interactions

Associated with this ambiguity in the interpretation of alliance as a concept is the ambiguity of language. In approaching a text, whether a treaty such as the Quebec Agreement or an informal telegram, the British tended always to a permissive interpretation and the Americans to a restrictive. In contrast the British appear to have felt moral obligation more keenly than the Americans – perhaps partly as a function of their dependence on such constructions in the absence of more binding commitments. The terms 'co-operation', 'co-ordination', 'collaboration' and 'exchange of information' were used almost interchangeably, but could imply markedly different interactions. Also striking is the tactical use of that ambiguity by the Americans (not least in their post-war interpretation of the term 'full and effective').[6]

The Argument

Each of the above-mentioned themes buttresses, in some fashion, the overall argument of the thesis, the essence of which is this: that the narrative of Britain's nuclear weapons programme is incomplete if its commonwealth context is ignored. That the Dominions ultimately came to play only a peripheral role in the overall history of Britain's nuclear deterrent matters little; the false starts and awkward reversals of the early period are as much a part of the narrative as the influences which would eventually predominate.

In broader context, it is reductive to portray the Second World War as presaging or catalysing Britain's fall from great power status: the narrative cannot be so simple as that Britain was an empire before and a non-entity afterwards. Nor can the narrative solely be one of the onset of imperial decline, for although that was the net effect measured over a space of decades, for those in positions of power and influence there was neither an expectation nor a desire to dissolve the bonds of empire.

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[5] JSM Washington to Cabinet Office, 25th November 1946, PREM 8/679 (TNA)
[6] See Chapter Six

The unique contribution of this thesis is therefore hoped to exist at several levels. Other than its novel angle of attack, several minor but important correctives to particular historiographical tropes have been suggested throughout the text, and at several points an effort has been made to challenge or build upon existing historiography. Prominent examples are easily summarised. In Chapter One, it is suggested that Oliphant exercised a rather more active influence on Frisch and Peierls' exploration of the fission question than has previously been noted. The same chapter demonstrates that nuclear ties with Canada were earlier and deeper than one might gather from existing accounts, and presents a detailed examination of the place of Canada within the deliberations of the MAUD committee (as well as analyses of Halban's diary *etc.*). Chapter Two particularly argues that the shift from the United States to Canada as the preferred domicile for Halban's work should be interpreted not so much as a retreat as a coherent, triangulated response, building on previous connections, intended to bind the UK and US programmes together. Chapter Three offers a detailed explication of the Conant Crisis with sensitivity to the Canadian perspective, and in particular presents a narrative of Canadian influence as having shaped British perspectives on how to approach the Americans. Chapter Four offers a somewhat novel perspective on the Canadian programme's leadership change, challenging the narrative of Halban as the problem *per se*, whilst also seeking to foreground the British difficulties post-Quebec, highlighting the renewed impulse to an independent programme and demonstrating the extent to which the Canadian influence again constrained British policy. Chapter Five places New Zealand and Australian experiences of interaction with wartime nuclear work in comparative perspective, drawing on additional archival material to build upon and enhance the analyses ventured by Galbreath and Priestley, and places British approaches to the Commonwealth on questions of uranium acquisition in their appropriate context. Finally, Chapter Six addresses British post-war nuclear research and development policy more firmly in the context of wartime experience, rather than treating it as a question approached *tabula rasa*; emphasises the extent of the challenges of the transition (recall Wrong's exam questions); considers the issue of Cockcroft's departure from Chalk River in context; and presents additional material on UK perspectives on commonwealth collaboration.

Returning to the broader perspective – for historians ought not to confine themselves only to painstaking reconstruction of *l'histoire événementielle* – two particular significances suggest themselves.

First, there are implications here for the understanding of nuclear history itself. This thesis shows the dynamics of early nuclear policy-making to have been less straightforward, and therefore to a historian far more interesting, than might first be believed. Adequate recognition of the significance of Commonwealth dynamics enriches the historian's understanding of key developments in the British nuclear programme, but also the United States' and the Dominions': Canadian nuclear history, in particular, is entirely conditioned by its origins. New Zealand and Australian nuclear histories from 1947 onwards meanwhile reflect a process of gradual disenchantment, associated with, and shaped by, the wider process of separation from Britain these states experienced. Application of a Commonwealth lens adds complexity to the narrative of nuclear history, but also makes possible sharper, more coherent explanations.

Second, there are parallel implications for commonwealth historiographies. Historians of empire have not tended to adopt nuclear technology – whether for military or civilian applications – as a lens for their studies. It is hoped that this thesis has demonstrated the potential merits of doing so. (Such a line of enquiry

might be situated equally profitably within the more fully developed literatures on 'imperial' science and decolonisation.) There is also the challenge of incorporating Commonwealth states' individual nuclear histories into their wider imperial and post-colonial contexts. National histories almost inevitably accentuate distinctiveness, and perhaps rightly so: Canada, Australia, New Zealand and South Africa each have their own particular histories of interaction with Britain and British imperialism, none of which can be reduced to a template. Yet these particularities were complemented by similarities, by common status and patterns of interaction. Moreover, the Dominions often construed their relations with the United Kingdom in comparison with their sister Dominions: witness the exchanges between New Zealand and Australia over wartime secondments, or South African desires for parity with Canada in post-war mineral negotiations.[7] This thesis demonstrates interesting interactions, especially between NZ and Australia, and implies that closer attention to common dynamics would be to the benefit of the individual countries' historiographies as well as to the wider historiography of the British empire.

Viewed concurrently, these two significances reiterate this thesis' core premise, that there was an inter-relation of imperial and atomic experiences. These inter-relations could exist at every level, from individual lived experiences to the very heights of state strategy. In the latter case, the overlap between the imperial and atomic imperatives occurred in a limited but determining form during the Second World War and became more substantive in the early Cold War: looking beyond the chronological scope of this thesis, it is clear that conditions around past and present Dominion engagement with nuclear development continued to shape attitudes to the waging of the cold war well into the 1950s.

The Relative Significance of Commonwealth Dynamics

So what role did the Commonwealth ultimately play in the shaping of Britain's early nuclear programme? Much depends on one's understanding of the term. The very label is a slippery one: it has always been somewhat of a convenient fiction. Yet there *were* tangible realities associated with Commonwealth and Dominionhood in particular that could influence events: constitutional bonds, networks of interchange, and personal connections. Alongside and in some senses underpinning these connections was a kind of shared cultural framework, a way of seeing the world that assumed that 'British nations' had certain core interests in common and should enjoy a closer form of alliance than could exist beyond the bounds of the Empire-Commonwealth. Thus conceived, it can be concluded that whilst the concept of Commonwealth was not the *main* driver of British or Canadian policy, it was at least a significant influence on the conduct of their relations with each other and with the United States; and that for Australia and New Zealand it *was* the principle lens through which those states encountered nuclear technology and developed nuclear policy. None of this is intended to overstate the significance of Commonwealth dynamics relative to other factors: in the holistic study of nuclear history it is a piece of the puzzle, not the key to the lock. The piece, however, is an important one: without it, the puzzle is incomplete.

[7] See Chapter Six

Commonwealth Historiographies Revisited

That the nuclear theme is underdeveloped in Commonwealth historiography is amply demonstrated in the fact that several recent works concentrating on Anglo-Dominion interactions within the periods of war and decolonisation bear nary a *reference* to the atomic bomb, never mind its bearing on Anglo-Dominion relations.[8] Yet the advent of the atomic bomb and the United Kingdom's post-war reckoning with its new fragility as a great imperial power were parallel, closely-associated challenges, and deserve to be treated as such. Britain in 1945 was already Lepidus in the triumvirate of great powers, and could justify her position only by reference to the diminishing asset of her empire and the potential of her nuclear arsenal. To choose between these two options was nigh impossible, but so too was it impossible to reconcile them.

Keeping in step with the Americans on nuclear developments had become an obsession in the war years, but the nuclear 'special relationship' which was the notional prize of British perseverance proved a double-edged sword: Britain could never have developed the bomb alone, and the necessity of securing it drove the MAUD Committee into ever-closer discussions with America, Britain's proto-ally and great hope, from which discussions emerged a fatal dependency that shaped British strategy for the duration of the Cold War. Dependence on the United States precluded closer ties with natural allies. Much though the British might wish to, they could not fully leverage the Commonwealth as an alternative to Anglo-American nuclear collaboration.

The wider literature carries the idea of an expectation of unconditional support from the Dominions, but even during the war this was never quite the case in the nuclear realm. Other than in the very earliest interactions with Canada, where acquiescence to British appeals was perhaps rather too readily assumed, every contact with a Dominion institution had the character of request and negotiation rather than diktat and expectation. Though its necessity may have been resented, implicitly or explicitly, a significant sensitivity to Dominion concerns was almost always observed. It is, however, true to state that the British generally mischaracterised or misinterpreted Canadian positions: it took a long time to realise that the interests of the two were not wholly aligned.

Similar perspectival shifts might equally be helpful in the nuclear historiographies of Canada and Australia. Canadian historiographies, concerned with the particularity of their nation's experience as the third point in the North Atlantic triangle and the corresponding transition from imperial attachment to one partner to a mediating sovereignty between the two (encapsulated in the title of a Canadian historical staple: 'Empire to Umpire'), might benefit from sensitivity to, and comparison with, wider imperial dynamics. In Australia the history of interaction with the British nuclear programme is forever interwoven with the complex legacies of nuclear testing on its territory – the only known instance of a sovereign non-nuclear state yielding such a privilege – which has been uncritically attributed to imperial dominance or residual Anglophilia.

[8] *cf.* Andrew Stewart, *Empire Lost: Britain, the Dominions and the Second World War* (London: Continuum, 2008)

The Future of Nuclear History

It is a curious thing that the first, official history of the United Kingdom's early nuclear programme should remain, five and a half decades after its completion, the authoritative account; but *Britain and Atomic Energy* and *Independence and Deterrence* between them retain an authority which no subsequent work has quite matched, and sketched out an analytical line from which few have deviated. This testifies in part to Gowing's exceptional scholarship, but perhaps also to lingering deficiencies in the field of nuclear history – one of which, this thesis has contended, is the neglect of Commonwealth dynamics as a relevant factor in every tier of nuclear decision-making. Gowing wrote in a period in which the British Empire, though truncated, was still extant, and this goes some way to pardoning her relative lack of attention to it: Empire was not, for the most part, a front-of-mind concept for those Britons who lived through it. The same excuse is not available to contemporary historians, who – perhaps lulled by decades of nuclear peace, and in the belief that imperial history constitutes a discipline apart – seem mostly to have been content either to conduct a kind of technical antiquarianism, listing and evaluating every new development in Britain's nuclear arsenal, or else to offer top-level analyses of British nuclear policy-making in the apparent belief that no source worth citing lies outside the PREM series at Kew.

In this respect the discipline of imperial history, more accustomed to moving between the particular and the general, the micro- and macro-historical domains, may provide something of a model. The discipline might equally provide useful case studies in the dispassionate handling of morally sensitive issues. Faced with the enormities of nuclear destruction it is all too easy to fall prey to the morally satisfying narrative of the scientists' loss of innocence at the hands of wily military men and politicians, and their subsequent moral awakening ('how inexorable was the trap into which the atomic scientists fell').[9] Hiroshima was a chastening experience for a great many of this thesis' protagonists, but instantaneous conversion to the cause of nuclear disarmament was seldom a consequence: the majority continued directly or indirectly to contribute to their states' nuclear development.

This thesis' acknowledged deficiencies might meanwhile point to possibilities for further research. For example, little has been said about French interactions with the British wartime nuclear work, though the contrast with Dominion experience is, in this sense, illuminating, and there is plenty that could be said about the extent to which the trajectory of French nuclear development was set by the wartime experiences of her émigré scientists at Montreal and Chalk River. Further research might also flow from simply continuing to trace the inter-relation of nuclear and imperial themes into later decades. Commonwealth dynamics remained a crucial influence on British nuclear policy for many years. The dynamics of Commonwealth interaction continued to evolve, as new Dominions came into existence and the older Dominions ploughed increasingly independent furrows, but the nebulous concepts of Commonwealth and Empire continued to have significance well into the Cold War. Only an appreciation of Commonwealth dynamics can explain the presence of a Canadian, Omond Solandt, on the bridge of HMS Campania to

[9] Brian VanDeMark, *Pandora's Keepers: Nine Men and the Atomic Bomb* (Boston: Little, Brown & Company, 2003), p.xi

watch the first British nuclear test in 1952, let alone the fact of that test having been conducted on Australian territory.[10]

Finally, it might be well to consider what relevance, if any, the practice of this kind of nuclear history might have for present issues. The inter-Dominion exchanges described in these pages would, by contemporary standards, constitute proliferation interactions. That Canada has since pursued only peaceful nuclear applications, that Australia never made good on tentative plans to explore nuclear weapons, and that New Zealand ultimately renounced nuclear technology altogether, may diminish the shock of this realisation, but it is nevertheless the case that the same basic assets of conceptual awareness, access to data, and practical experience which the Dominions gained from Britain underpin contemporary proliferation interactions. Current nuclear weapons states, including members of the Commonwealth, have benefitted from such exchanges. It would be dangerous to seek to apply the lessons of the past too directly to the present, but more dangerous still to ignore the past altogether, or blithely to accept a caricatured version of its complexities. There now exists an opportunity to inject a degree of historicity into a policy debate which is presently dominated by other disciplines. History presents few easy answers to contemporary problems – it never will – but there is nevertheless value in historians' presence in the discussion, if only to note that monocausality is a chimera of the social sciences; that the diffusion of nuclear knowledge can take place through routes other than gift or espionage; that inter-state nuclear interactions can occur simultaneously at multiple interconnected tiers of exchange; and that early experiences, even at very low levels, can shape states' attitudes to nuclear issues for decades to come. In sum: nuclear and imperial history both remain deeply relevant to contemporary concerns, and nowhere more so than in the spaces in which they overlap.

[10] Solandt's presence at the test – in an official capacity, and with a significant degree of access to technical information – appears not to have been discussed in any hitherto existing historical work.

Appendix One:
Chronology of Key Events

1939

3 May	'The Possibility of Producing an Atomic Bomb: A Review of the Position'.
30 May	Oliphant writes to Lawrence in the U.S., referencing UK interest in nuclear fission.

1940

1 February	Transfer of Joliot's research programme to the French *Ministere de l'Armament*.
10 April	First meeting of the (not-yet-named MAUD) committee to discuss the implications of the Frisch-Peierls memorandum.
20 April	Cockcroft writes to Boyle on behalf of MAUD, enquiring about heavy water in Canada.
22 April	Peierls complains about his and Frisch's exclusion from nuclear work.
24 April	Second meeting of the MAUD Committee.
16 May	Boyle responds to Cockcroft's query about heavy water supplies; MAUD Committee learns of the American view that 'there was no possibility within practical range of using uranium either as a power source or as an explosive'.
17 May	Informal MAUD meeting at Birmingham.
19 June	Third Meeting of the MAUD Committee.
20 June	Frisch and Peierls cleared to participate in MAUD Committee; MAUD Committee make official enquiry of NRC regarding Canadian uranium supplies.
10 July	Fourth meeting of the MAUD Committee: transfer of Halban and Kowarski to North America is discussed.
7 August	Fifth meeting of the MAUD Committee.
17 September	Sixth meeting of the MAUD Committee, now reconstituted as the Policy Committee; First meeting of the MAUD technical committee.
25 October	Americans approve draft agreement for UK liaison.

1941

8 January	Seventh meeting of the MAUD (Policy) Committee. Second meeting of the MAUD Technical Committee.
9 April	Third meeting of the MAUD Technical Committee.
19 May	Eighth meeting of the MAUD (Policy) Committee.
26 June	First draft MAUD report circulated.
15 July	Final MAUD report signed by Thomson.
29 July	Completed MAUD reports received by Pye, MAP Director of Scientific Research.
27 August	Moore Brabazon passes MAUD report on to Lord Hankey and SAC.
30 August	Churchill supports action on MAUD report (*i.e.* establishment of Tube Alloys).
3 September	Chiefs of Staffs Committee urge that the programme be based in the UK.
17 September	Casey informs Rivett that Oliphant has briefed him on uranium work.
23 September	Oliphant meets with Lawrence at Berkeley (to 24th).
25 September	Scientific Advisory Committee Report sent to Anderson.
3 October	MAUD report officially transmitted to US.
11 October	Roosevelt writes to PM suggesting possibility of US and UK conducting joint programme.
27 October	Pegram & Urey visit United Kingdom.
1 December	Churchill finally replies to Roosevelt's letter.

1942

15 February	Oliphant, troubled by the imminent fall of Singapore, offers his services to Australia.
20 March	Oliphant departs UK for Australia.
27 May	Oliphant arrives in Australia.
15 June	Mackenzie King discusses UK nuclear work with Malcolm MacDonald – his first formal briefing.
2 September	Agreement that Halban's team should go to Canada.

24 September	Discussions begin regarding practical arrangements for Halban's team to be based in Canada.
26 September	United Kingdom agree in principle Mackenzie's memorandum on Anglo-Canadian project.
12 October	British & Canadians meet to finalise memorandum for Anglo-Canadian project.
26 October	Oliphant departs Australia for UK.
1 November	Montreal agreed as location for the Anglo-Canadian heavy water work.
15 December	Conant asks for a visit from Chadwick and Peierls, to meet with Oppenheimer and other theoreticians.

1943

2 January	Conant speaks with Akers and Mackenzie via telephone, telling the latter he was sending 'a letter that sounds 'more harsh than was really intended' (*i.e.* the Conant Letter).
7 January	Conant's memorandum on co-operation dated.
13 January	Akers receives Conant memorandum.
18 January	Mackenzie in Washington to meet Conant and Bush.
26 January	Akers meets Groves and Conant to discuss Conant memorandum line-by-line.
3 March	Halban told to postpone his visit to US.
12 March	Mackenzie learns that the UK has vetoed Halban's visit to US.
1 April	Last of the equipment arrives at Montreal Laboratory.
22 July	Bush and Stimson, in London, meet with Churchill, Anderson, Cherwell, Perrin.
26 July	Groves in Ottawa, meets with Mackenzie.
1 August	Anderson travels to Washington to negotiate Quebec Agreement.
10 August	Anderson, now in Quebec, hands Churchill new agreement.
12 August	Discussion on Experimental Programme of T.A. Montreal Group.
19 August	Quebec Agreement signed; Chadwick, Simon, Oliphant & Peierls arrive in North America.
24 August	Llewellin begins repeated attempts to get in touch with Stimson to convene CPC (to 2nd September).
1 September	Chadwick, Peierls and Oliphant in Washington for discussions with Conant and Groves.
1 September	Quebec agreement concluded.
3 September	Chadwick and Oliphant dine with Conant, and informally discuss CPC.
8 September	First (informal) meeting of Combined Policy Committee, called by Stimson.
13 September	Mackenzie, Oliphant, Groves, Oppenheimer, Chadwick and Conant meet to discuss UK contribution.
18 September	Oliphant and Chadwick meet with Groves and Oppenheimer in Washington; Groves visits Montreal.
19 November	Oliphant arrives at Berkeley.
3 December	Massey arrives at Berkeley.

1944

4 January	TA Technical Committee meets (across four days) to discuss future plans.
9 February	Massey argues for release of Bates and Gunn.
17 February	Inconclusive meeting of the CPC; question of Canadian heavy water work referred to sub-committee.
23 March	Rivett responds to British request for Burhop by suggesting a high-level approach including question of uranium ores.
28 March	UK High Commissioner visits Montreal in an effort to bolster waning morale.
13 April	CPC approval for 5MW HW pile in Canada.
13 June	Agreement and Declaration of Trust.
15 June	Smuts writes to Churchill, giving personal analysis of the implications of the atom bomb.
23 June	Anderson speaks with Fraser about the secondment of NZ scientists.
28 June	Peierls transfers from New York to Los Alamos.
5 July	Marsden puts question of New Zealand support for UK Tube Alloys programme to acting Prime Minister Dan Sullivan.
1 October	Australian government told no further physicists needed for Berkeley or Montreal.
13 October	Mackenzie's appointment as president of NRC made permanent.
4 November	Discussion in Canada on future piles in Canada and UK.
11 November	Discussion in Chadwick's Washington office on the subject of British post-war plans.

1945

15 January	Second future systems meeting
12 February	Third future systems meeting

25 April	Truman first briefed on Manhattan Project by Stimson and Groves
8 May	VE Day
14 May	Fourth future systems meeting
29 May	Fifth future systems meeting
7 June	Sixth future systems meeting
26 June	UN charter signed at San Francisco
1 July	Smyth completes preface to his report
4 July	UK concurs in use of atomic bomb on Japan
15 July	Potsdam conference begins
16 July	Trinity test
19 July	Eighth future systems meeting
26 July	UK election results; Attlee replaces Churchill as Prime Minister
26 July	Proclamation to Japan
6 August	Hiroshima bombing
12 August	Smyth Report Published
	British statement on atom bomb published
13 August	Canadian statement on atom bomb published
28 August	Attlee's memorandum on 'The Atomic Bomb'
5 September	ZEEP becomes operational at Chalk River: the first nuclear reactor outside the United States
25 September	Attlee writes to Truman, broaching idea of meeting to discuss nuclear issues
1 October	South African CSIR established
12 October	Attlee sends follow-up telegram to Truman
14 October	Evatt presses for Australian inclusion in UK nuclear work
16 October	Attlee writes to Truman suggesting immediate conference
17 October	Dominions sent copies of Truman-Attlee nuclear correspondence
1 November	Fifth printing of Smyth report incorporates British & Canadian statements as appendices
8 November	Chifley telegrams Attlee asking to be kept informed of Washington discussions, making a case for Evatt to be included in discussions
13 November	Discussions, in Washington, about Cockcroft's possible departure; Canadians argue strongly he should stay.
15 November	Washington Declaration
22 November	Directorate of Tube Alloys officially moves into Shell Mex House
3 December	Cockcroft confirms to Mackenzie that he intends to accept directorship of UK AERE
15 December	British request made to Smuts for in-principle agreement regarding uranium supplies
21 December	Smuts gives a somewhat lukewarm response to the British uranium request

1946

1 January	Directorate of Tube Alloys becomes Department of Atomic Energy
25 January	NZ Cabinet approves Marsden's plans for New Zealand nuclear development
15 February	CPC informed of British decision to build large scale reactor to produce plutonium
1 March	Ninth future systems meeting (Canadian focus)
10 April	Tenth future systems meeting (Canadian focus)
13 April	Zinn visits Mackenzie to discuss directorship
24 April	Bevin raises idea of a UK plant in Africa
5 June	Eleventh future systems meeting (Canadian focus)
29 July	Mackenzie returns to Canada from Britain, having secured Lewis for Chalk River
10 September	Lewis arrives in Canada
18 September	Cockcroft hands over Chalk River Directorship to Lewis
16 November	Portal tells Attlee that a formal decision on bomb is required

1947

8 January	Attlee decision via GEN 163 that Britain should build the bomb

Appendix Two:
Dramatis Personae

The purpose of this appendix is to provide brief biographical sketches for each of the individuals named in the body of the text. Persons mentioned only in footnotes are generally omitted: these are often tangential or administrative figures. The focus is solely on individuals' activities in the period 1939-1947, with prior details included only where directly relevant to the thesis. Details of later careers are similarly omitted except where they cast particular light on themes explored in the thesis.

Glossary

23	Code for Uranium 233, a fissile isotope of uranium
25	Code for Uranium 235, a fissile isotope of uranium
49	Code for Plutonium – a reversal of its atomic number, 94
94	Plutonium (atomic number 94)
ACAE	Advisory Committee Atomic Energy
ADRDE	Air Defence Research and Development Establishment
AERE	Atomic Energy Research Establishment (*i.e.* the British research centre at Harwell, though note that the acronym was in use before Harwell's selection as the site)
BCSO	British *Central* Scientific Office, to 1944; thereafter British *Commonwealth* Scientific Office; sometimes referred to within UK correspondence simply as CSO.
CDT	Combined Development Trust
Chalk River	Canadian nuclear research facility; successor to the Montreal Laboratory; location of NRX and ZEEP
CoS	Chiefs of Staff
CPAE	Controller [of?] Production of Atomic Energy, *i.e.* Portal
CPC	Combined Policy Committee
CSAR	Chief Superintendent Armament Research; Penney's post-war title.
CSIR	Council for Scientific and Industrial Research/Suid-Afrikaanse Wetenskaplike en Nywerheidnavorsingsraad (South Africa)
CSIR	[Australian] Council for Scientific and Industrial Research, created October 1945.
CSIRO	Commonwealth Scientific and Industrial Research Organisation; replaced CSIR in 1949.
CSO	See BCSO
CSSAW	Committee for the Scientific Survey of Air Warfare, original parent of the MAUD Committee.
Cyclotron	Type of particle accelerator pioneered by Lawrence in California prior to the Second World War; valuable for a variety of nuclear physics applications.
D.At.En.	Department of Atomic Energy
D2O	Deuterium oxide; that is, heavy water (see below).
DepAtEn	See D.At.En.
DSIR	Department of Scientific and Industrial Research (UK and New Zealand)
DSR	Director of Scienitific Research
DTA	Directorate of Tube Alloys, and by extension Director of Tube Alloys
Dupont	American industrial concern, involved in Manhattan Project delivery
EM	Electromagnetic (as in EM separation)
Fast neutron	Free neutron unslowed by multiple collisions. Fast neutrons possess significant kinetic energy, making fission far more likely if captured by a nucleus; however, the likelihood of capture (the cross section) is relatively low. Fast neutron interactions underpin nuclear explosions.
GEN 75	Committee convened by Attlee to discuss atomic energy.
GLEEP	Graphite Low Energy Experimental Pile, the first reactor to enter operation at Harwell. Charles Watson Munro and various other New Zealanders contributed to its construction.
H.M.G.	His Majesty's Government (*i.e.* any of the Dominion Governments, including the UK)
Harwell	A former RAF base, site of the Atomic Energy Research Establishment, and used therefore as a metonym for the establishment itself.
HC	High Commissioner

Heavy Water	(D2O, deuterium oxide) A form of water wherein most or all of the water molecules are constituted with deuterium, an isotope of hydrogen with both a proton and a neutron, as opposed to the more common form which consists only of a proton. Particularly valuable as a neutron moderator sswithin a pile.
HEU	Highly enriched uranium.
HW	Heavy Water
ICI	Imperial Chemical Industries
Los Alamos	Site of the American theoretical physics and weaponization research work
LSD	Low Separation Diffusion (as in 'LSD Plant')
Manhattan Project	The American wartime nuclear weapons project, under US Army control and headed by General Leslie Groves
MAP	Ministry of Aircraft Production (and by extension, Minister of Aircraft Production)
MAUD	Name given to the committee tasked with considering the implications fo the Frisch-Peierls memorandum and the practicality of developing the bomb. Also referred to as M.A.U.D. and Maud, more or less interchangeably. The name MAUD derives from a message Bohr had had transmitted to Cockcroft from occupied Denmark; the final words, MAUD RAY KENT, were initially taken as some form of coded reference to radium or uranium. (The reality was more prosaic: they referred simply to a woman named Maud Ray, residing in Kent).
Mayson	Codename for nuclear weapons research proposed by Roosevelt for use in top-level correspondence between UK and US governments.
McMahon Act	The Atomic Energy Act of 1946. United States legislation placing the American nuclear programme under civilian control; it had as its consequence a significant restriction of nuclear interchange with other states, including the United Kingdom and Canada
MI	Military Intelligence
MoS	Ministry of Supply
NATO	North Atlantic Treaty Organizations
NDRC	National Defence Research Committee; American body chaired by Vannevar Bush
NRC	(Canadian) National Research Council
NRX	'National Research Experimental', the second operational reactor at Chalk River. A heavy-water-moderated, light-water-cooled experimental reactor.
OSRD	Office of Scientific Research and Development; American body headed by Vannevar Bush which took over most of the work of the NDRC
Pile	Original terminology for a nuclear reactor
PJBD	Permanent Joint Board on Defense
Polymer	Codename for heavy water
Pu	Plutonium
S-1	Executive committee of the NDRC and OSRD, focussing on uranium fission. Also S1, S.1 etc.
SAC	Scientific Advisory Committee; Lord Hankey's committee
Slow neutron	Free neutron slowed by multiple collisions; less energetic than a fast neutrons, but with a larger cross section (meaning a greater likelihood of capture). Cannot therefore produce a nuclear explosion, but vital for production of nuclear energy in a reactor.
Synchrotron	Type of particle accelerator, comparable to a cyclotron but developed later; a key aspect of Oliphant's post-war research programme
T.A.	(TA etc.) see Tube Alloys
T.A.1	(Also TA1, TA.1 etc.) Name given to aspects of the Tube Alloys programme relating to fast neutron applications of uranium fission - *i.e.*, the bomb project. This encompassed programmes for uranium enrichment by a variety of methods, as well as experimental and theoretical work on the reaction itself.

TA2	(Also T.A.2, T.A.2 etc.) Name given to aspects of the Tube Alloys programme relating to slow neutron applications of uranium fission. These were initially believed to be relevant only to the production of power; the discovery that plutonium, a product of the reaction, was likely to be fissile, later meant that this branch of the work also assumed military importance.
TRE	Telecommunications Research Establishment; centre of UK radar research during the war.
Tube Alloys	Purposefully bland codename given to the UK nuclear programme from late 1941
U-233,	U.233 Uranium 233, fissile isotope of uranium.
U-235	Uranium 235; fissile isotope of uranium.
U308	A compound of uranium.
Valley	Name for the facility at Rhydymwyn where much of the British work on gaseous diffusion took place.
X	Code name used by the Manhattan Project to refer to the enrichment facility at Oak Ridge.
Y	Code name used by the Manhattan Project to refer to Los Alamos.
YOKE	See 'Y', above.
ZEEP	Zero Energy Experimental Pile, the first reactor to go live at Chalk River.

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AB

Note: in December 2018 all files within the AB series were withdrawn from public access. These files had previously been freely available to researchers at the National Archives.

AB 1/1	General Administration
AB 1/2	Berkeley
AB 1/3	Transfer of Group from Berkeley to X
AB 1/4A	Knoxville
AB 1/4B	London T.A. Staff Movements
AB 1/5	New York
AB 1/6	Personnel (General)
AB 1/7	Staff list of British scientific officers attached to the British Supply Council in North America
AB 1/8	MAUD Committee - Minutes of Meetings
AB 1/9	MAUD Committee - Papers relating to Atomic Bomb
AB 1/34(A)	Visit of Akers, Simon and Halban to United States of America
AB 1/34(B)	Directorate of Tube Alloys - Chalk River Project Canada General Correspondence with DSIR
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AB 1/48	Visits to U.S.A. and Canada - Professor R. Peierls
AB 1/49	Visits to U.S.A. and Canada - Professor F. Simon
AB 1/50	Transfer of Halban Team to Canada
AB 1/51	Visit to United States of America Dr. J. P. Baxter
AB 1/52	Visits to U.S.A. & Canada Dr. Thelwall Jones
AB 1/53	Permission to use and issue information obtained in working on Tube Alloy project
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AB 1/64	U.K. Organisation - Transfer of T.A. from D.S.I.R. to M.O.S.
AB 1/82	Uranium - Belgian Congo
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AB 1/86	Heavy Water - supplies and stocks
AB 1/87	Heavy Water for Canadian Team
AB 1/110	Investigation of nuclear physics developments in Germany
AB 1/113	Heavy water Pile - Policy re erection in Canada
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AB 1/136	Canadian Papers - Staff Questions after 1st April 1943
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AB 1/139	D.T.A. - U.K. General Information File
AB 1/141	Cables (from Canada)
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KV 2/1661	Rudolf Ernest PEIERLS (1) / Eugenia PEIERLS (2), aliases (2) Yevgeniya KANNEGISER; Eugenia KANNEGIESSER; Zenia PEIERLS
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